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The Knight Gasoline Engine With Sliding-Sleeve Valves.

A few years ago a distinctly new type of valve for four-cycle gasoline engines was invented in this country by Mr. C. Y. Knight, an American. His effort to interest the automobile manufacturers of the United States in his invention proved fruitless, but after transferring his activity to Europe he was almost immediately successful. Engines equipped with the Knight valve system were quickly adopted as standard on a number of prominent European motor cars, including the Panhard, Mercedes and Daimler makes. A somewhat tardy American recognition of the merits of the Knight engine is found in the recent announcement of the United States Motor Co. that an engine of this type will be used on the 1912 model of the Columbia motor car. We are informed also that the Knight engine is to be used on the Stearns car, made by the F. B. Stearns Co., of Cleveland, Ohio.

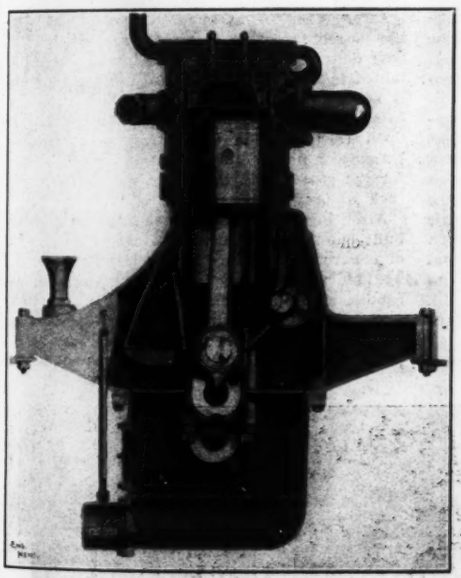


FIG. 1. SECTIONAL END VIEW OF THE COLUMBIA-KNIGHT GASOLINE MOTOR-CAR ENGINE.

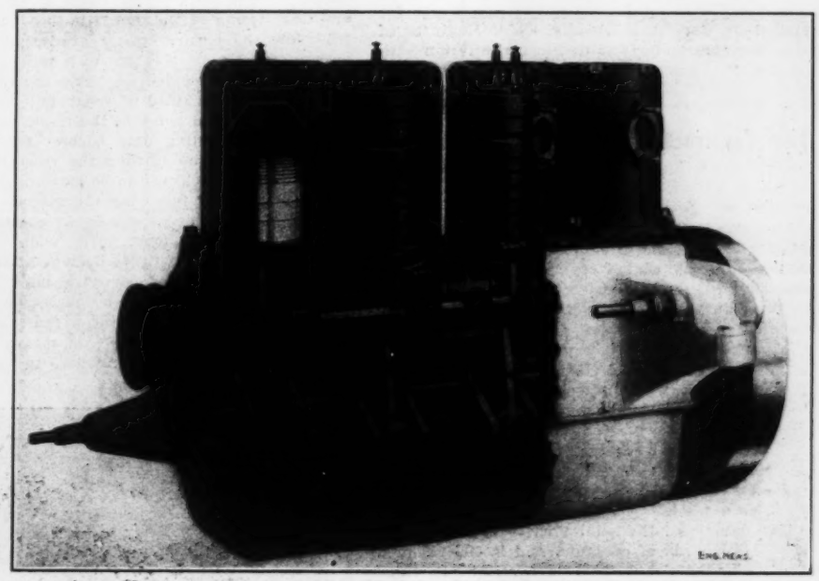


FIG. 2. PART SECTIONAL VIEW OF COLUMBIA-KNIGHT ENGINE SHOWING VALVE SHAFT AND SPLASH-OILING SYSTEM.

A sectional end view of the Columbia-Knight engine is shown in Fig. 1. The usual poppet valves of the four-cycle engine with their push rods, springs and cams are altogether absent. Instead, there are two sliding sleeves, fitting one within the other, which together form a double lining to the cylinder. The piston slides within the inner sleeve. The inlet and exhaust ports are simply transverse slots on opposite sides of each sleeve. For either port to be open the sleeve slots must register both with each other and with the ports through the cylinder wall.

The sleeves are driven through short connecting rods by a secondary crank-shaft driven from the main shaft by a silent-chain drive. The sprockets are proportioned to drive the valve shaft at half the speed of the main shaft. The inlet slot of each sleeve is slightly lower than the exhaust slot, instead of being directly opposite, and the cranks driving the two sleeves are about 90° apart, so that one sleeve reaches the top of its stroke and starts down again while the other is still rising. Thus the inlet port is opened on one stroke of the sleeves and the exhaust port opens on the return stroke. Since the valve shaft turns at half the speed of the main shaft this gives the desired valve conditions for four-cycle operation—that is, the inlet valve is open during every second downstroke of the piston and the exhaust valve is open during the preceding up-stroke.

The principal advantages claimed for this engine are the elimination of the noise of poppet valves and valve gear and the possibility of greatly increased port areas. Given a really effective muffler for the exhaust the sound of valve gears, push rods and valves is the most conspicuous noise left in a well-built automobile engine, so that the first-named advantage is of real importance.

The diameter of poppet valves in the ordinary engine is limited by several practical considerations, among which are the undesirability of increasing the volume of the combustion space. As a result the valve areas are ordinarily so small that gas velocities of between 7,000 and 8,000 ft. per min. are necessary at full speed. This is 20% more than is permissible in a well-designed steam engine and results undoubtedly in wire-drawing or throttling of the charge at high speed, which reduces the maximum power below what would be otherwise obtainable. In the Knight engine the valve area may readily be made from two to three times that ordinarily provided in the poppet-valve type, and this, too, without affecting the volume of the combustion chamber, which is shaped like the frustum of a cone without any off-set or side pocket. This feature, it is claimed, coupled with the more accurate and uniform timing of admission and cut-off throughout any range of speed due to the elimination of dependence on springs and cams, enables the Knight engine to develop more power than a poppet-valve engine of the same dimensions. The cylinders, pistons and valve-sleeves are of gray cast-iron, cast, however, in European foundries and imported to this country. This seems to evidence a belief in the frequently heard assertion that more skilled foundrymen on this class of work are found in Europe than in the United States. These parts are finished by machining and grinding. The valve shaft is cut from the solid and is left of full diameter at

the central bearings as shown in Fig. 2, which gives a sectional view of a four-cylinder engine.

The lubricating system, which can be understood from this same view, is designed to automatically proportion the amount of lubrication to the load on the engine. It is a development of the system already in use on Columbia engines of the poppet-valve type. Each connecting rod has a scoop-mouthed oil hole at its lower end which dips at each revolution into a narrow trough of oil. An individual trough with its long dimension at right angles to the crank-shaft is provided for each connecting rod. The four troughs are all rigidly attached at one end to a single rocker-shaft extending lengthwise of the crank case. The rocker-shaft is mechanically connected with the throttle lever in such a way that when the throttle is opened or closed the oil troughs are correspondingly raised or lowered. Thus when the throttle is opened the troughs are raised toward a horizontal position and the connecting-rod scoops dip deeper into the oil; and when the throttle is closed and the troughs are lowered to a steeper slant some of the oil runs out and less is supplied to the scoops.

The overflowing oil is drained through a wire screen to the reservoir at the bottom of the crank case, whence it is supplied to the troughs again by a plunger pump with by-pass piping to the sight feed indicator on the dash of the car. The depth of oil in the crank-case reservoir is indicated by a ball-topped rod mounted on a cork float, as shown at the left of the crank case in Fig. 1.

As applied to the Columbia car, the engine will be made with four cylinders, cast in pairs, each 4⅞ ins. in diameter by 5½-in. stroke. This would be rated, according to the approximate general formula of the American Licensed Automobile Manufacturers' Association, at about 38-HP., but it is claimed that due to the superiority of the Knight valve system the engine can develop 70-HP. without overspeeding. The engine was designed by Charles E. Reddig, Chief Engineer of the Columbia Motor Car Co., in consultation with Mr. C. Y. Knight.

The Construction of the New Hauserlake Dam.

By BARRETT SMITH.*

The article "Difficult Foundation Work at the Hauserlake Dam, Montana," in Engineering News, June 22, while very briefly pointing to a few of the construction difficulties which were involved in this reconstruction work, was chiefly devoted to an account of one particular part of the work—the use of pneumatic caissons in reaching deep bed rock on a portion of the dam. This piece of work while especially noteworthy was but one of a number done under great difficulties, and as the appearance of the new dam gives little indication of the succession of problems solved, the writer has judged it of interest to place on record a brief connected account of the work as a whole.

The dam is of the solid gravity type, containing 85,000 yards of concrete, and is 490 ft. long, 132 ft. high at its deepest part, and 85 ft. thick through the base. The normal working head is 65 ft. It was built by the Stone & Webster Engineering Corporation, of Boston, to replace a dam which failed early in 1908 by undermining of the foundations.† This old dam was part of a 20,000-HP. hydro-electric plant, and was of structural steel built on a concrete pad laid over a line of steel sheet piling. There was something like 1,200 tons of steel in this structure, and its wreckage was heaped up in the tailrace below the power station and in the river proper at the dam site and immediately below it, this wreckage being buried in boulders and gravel. When the dam failed, the resultant rush of water apparently scoured out the gravel and boulders lying between the pad of concrete and bed rock, which was between 40 and 50 ft. deep. This was indicated by finding pieces of wrecked steel within a few feet of bed rock, which had been buried in boulders and gravel by the next spring floods.

*Stone & Webster Engineering Corporation, 147 Milk St., Boston, Mass.

†See Engineering News, Nov. 14, 1907, and April 30, 1908.

FIG. 1. HAUSERLAKE POWER HOUSE AND REMAINS OF OLD STEEL DAM, SHOWING THE WRECKAGE IN TAILRACE. (SEPT. 16, 1908.)

Diamond-drill borings, taken across the river along the upstream and downstream lines of the old dam, showed solid ledge at depths varying from 15 to 65 ft. below normal water level, the deepest point being about one-third of the width of the river extending from a point 160 ft. from the west bank easterly for a distance of some 200 ft.

The problem of building the new dam had two parts, (1) the excavation, clearing of wreckage and unwatering of the dam site to a depth of 65 ft. below the natural water grade, and (2) the excavation and clearing out of a tailrace.

It was finally decided to tackle the two propositions together instead of separately and to unwater some eleven acres of the river bed by constructing a diverting dam several hundred feet above the dam and turning the river through a timber flume, which was to be located on the west bank of the river following the curvature of the natural contour line as closely as possible. This flume was 1,400 ft. long, 50 ft. wide and 12 ft. deep. It was built with its floor at about normal water grade and rested partly on piles, partly on a shelf excavated to take it, partly on rock fill and for a short stretch over a fault in a slope on timber cribs sunk in 40 ft. of water.

The diverting dam was only high enough to send the water through the flume. It was formed by a double line of piling, with waling strips, and a line of Wakefield sheeting backfilled with rock and earth.

These temporary works were completed and the river was sent through the flume Feb. 25, 1909. In the meantime the dismantling of the remains of the old dam was in progress, the motor-driven sand, rock-crushing and mixing plants were put in readiness for operation, a motor-driven pumping plant, and the excavating plant, derricks, etc., were assembled.

After a service of about a month, and before the possibility of pumping out the enclosed area was demonstrated, the flume intake was undermined by leakage and washed out, carrying with it several hundred feet of the flume. In order to save the rest of the flume, it was necessary to open the diversion dam. As the annual high water was nearly due, operations were suspended for the season and the flume was ballasted with rock to prevent flotation.

After high water was past a new intake was built close to the west bank over a cut-off wall of concrete resting on bed rock which insured it against undercutting. The diverting dam was rebuilt with sheet steel piling driven to bed rock from this cut-off wall across the river to the east bank (see Fig. 3). A backwater dam also of steel sheeting was driven across the river at the

FIG. 2. NEW HAUSERLAKE DAM COMPLETED.
(From high cliffs on west bank. May 21, 1911.)

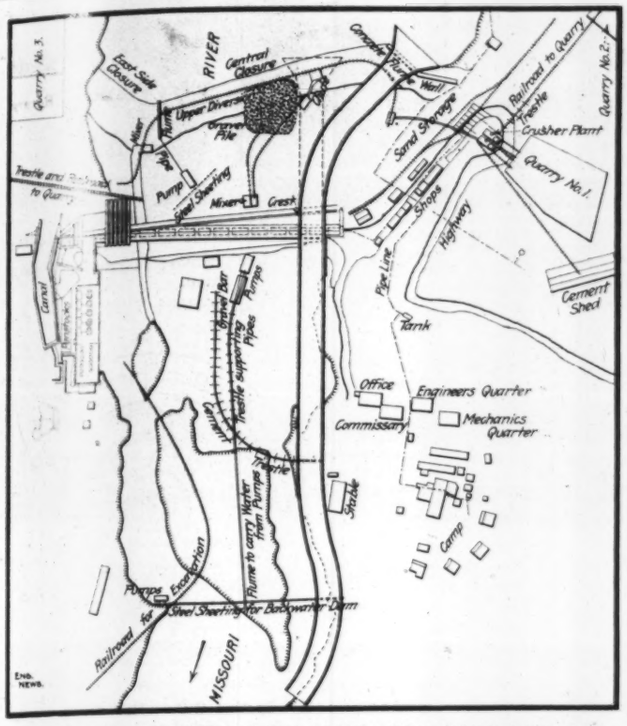


FIG. 3. PLAN OF CONSTRUCTION PLANT, NEW HAUSERLAKE DAM.

lower end of the flume. About 1,000 tons of steel sheeting were driven in all, the pieces in the deepest portion of the river going down 70 ft. to bed rock. Two openings were left in the upper diversion dam; in the center of the river and near the east bank. The center opening was passing water to a depth of about 20 ft., and in order to prevent any further scouring while this closure was being made, dowel piles to the number of 800 were driven on 6-ft. centers and then filled with rock dumped among them from scows and from a trestle spanning a gap by which means the entire bottom of the opening was rock paved. The closure was completed by sheet piling and backfilling. The closure of the east gap was made by means of a brush mat, 150 ft. long, 24 ft. wide and 12 ft. deep, constructed in the river above and floated down to place where it was sunk with rock and covered with fill.

While this work was being done, arrangements for pumping and excavating were completed. It was anticipated, from the character of the rock on the banks of the river and from observations made as to the character of the material overlying the bed rock, that there would be a large amount of leakage to be handled inside of the cofferdams. The pumping equipment was to be driven by electric power furnished from the Canyon Ferry plant with a transmission distance of about 40 miles to Hauserlake. Considering the probable large amount of leakage through the cofferdam and the possibilities of interruptions in electric power carried over a long transmission line, it was decided to place the pumping equipment on scows. This pumping equipment was all installed and connected ready for use. A large engine was placed on the upper diversion dam to operate a drag-line scraper, and six derricks were placed to assist in the work of handling the excavation.

A second testing of the flume began Oct. 17, 1909, when water was turned into it again. A weakness developed at a point over the cribs just below the dam site owing to settlement of the rock fill between the timber cribs at the fault before mentioned and it was necessary to close the water off and place two more cribs under the flume (see Fig. 4). Water was turned into the flume and pumps started in November.

At the first stage the pumping equipment consisted of six 12-in., two 6-in., and one 8-in. centrifugals. As the pond was pulled down, five more 12-in. pumps were added, boosting the requirement to some 2,000 HP. to operate the entire pumping equipment. The pond was lowered rapidly for the first 20 ft., and a second drag-line scraper was put to work on the excavation at the dam site, which amounted to about 40,000 cu. yds. The advantage of using the drag-line scraper on this excavation was its effectiveness in excavating several feet below water.

The steel wreckage buried in the material to be excavated proved a tremendous handicap and added greatly to the cost and time for completing the excavation. Pneumatic tools and an oxy-acetylene burner were used with good effect to get the steel in the wreckage apart so that it could be more readily handled.

During December, 25,000 yds. were removed and concreting was commenced on bed rock in the river bed on the west slope 50 ft. from the flume. On the east side, the foundations of the old dam were removed, bed rock was cleared for a length of 210 ft. and concreting was begun in this area of the main dam in January, 1910. At this point it was necessary to drive a subcofferdam of steel sheeting just above the line of the new dam, partly to reduce the amount of excavation and partly to get better control of leakage through the material.

On the island formed by the wreck and debris below the dam opposite the power-house when the steel dam failed, a steam shovel was started on a 40,000 yd. cut. In removing this material the oxy-acetylene burner was used to great advantage, as hundreds of tons of steel were buried in and under big blocks of concrete which had been washed down to this point.

Progress for several weeks was very satisfactory, but was interrupted for a fortnight early in March when a sudden thaw caused the river to rise to a stage unprecedented for the season. It overflowed the flume, the sides of which had been raised to a total height of about 16 feet, thereby giving it a capacity of about 10,000 cu. ft. per sec. The area inside the cofferdams was completely flooded for a time. No real damage was done, however, except by loss of time. The pond was soon pumped down again, and through April the work advanced rapidly. At the close of the month 32,500 yds. of concrete, or 70% of the total yardage below river level, had been placed.

A great deal of trouble was experienced in handling the leakage through the river bed, most of which appeared on the west end of the dam. Sectionalizing by steel sheeting and sack dams was necessary in order to make any progress at all. It became evident early in the month that the full section could not be brought up to water level before the annual high water and an attempt was made to push the upstream part of the structure across in order to avoid the necessity of rebuilding the diverting dam which was sure to go out during the flood. Besides the east end of the dam which was completed up to water level for its full section, this cut-off wall had been extended 130 ft., leaving a gap of only 27 ft.

This cut-off wall was built on bed rock reached at grade 3515 on the average and in one place to the extreme depth of grade 3508. The top of this wall was brought up within a very few feet below normal water level for the greater part of its length, and the lowest point of the top of the wall was about 10 ft. below the normal river level, or at grade 3560, when, on April 29, 1910, several weeks ahead of its normal date, the river rose rapidly and in order to save the temporary work, the diverting dam was opened again and work suspended.

The excavation and clearing of wreckage from the tailrace had been completed by this time and it was, therefore, unnecessary to again unwater this part of the work. It was felt that the diverting dam and flume would suffer severe damage from high water and would require considerable time for repairs and it was decided to use pneumatic caissons to complete the balance of the underwater work. The Foundation Co., of New York, was called on to undertake this part of the work and started operations in June, 1910, as related in Engineering News, July 22, 1911.

At this time a total of 38,000 yds., or 45% of the whole work had been placed, the deepest section of bed rock had been covered with concrete, about 90% of all the bed rock within the dam-site area below the river level had been concreted, approximately three-fourths of the dam was completed to its full section to river level and the cut-off wall on the upstream side extended from the finished section to within 27 ft. of the bed rock above river level on the west side.

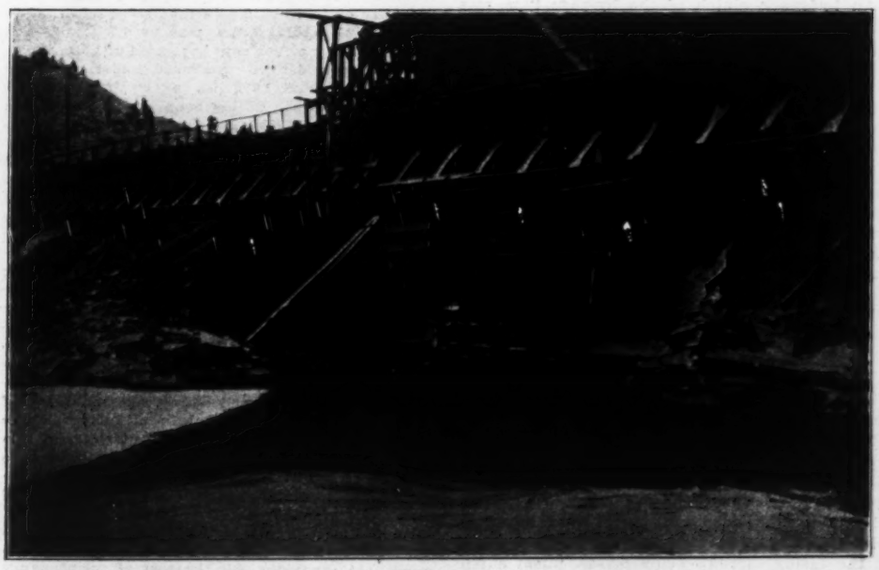


FIG. 4. CRIBWORK UNDER FLUME JUST BELOW DAM SITE. (DEC. 4, 1909.)

The details of this interesting caisson work has been given in the recent article mentioned. While preparation of the caissons was under way the section of flume where it crossed the lines of the permanent dam was torn out and replaced by a section 15 ft. narrower, this section having a concrete floor on a shelf of bed rock and concrete sides so that it could later be made a part of the permanent work.

The sinking of the first caisson was begun in the latter part of July and the cofferdam of caissons was completed and sealed Dec. 23, 1910. While the caisson work was going on, the cut-off wall had been brought up above water and the superstructure above it completed with the exception of some temporary sluiceways.

Pumping between the line of caissons began about Jan. 1, 1911, and excavation was started on the west slope next the flume. This was the critical area, as it contained the fissures and pockets from which most of the leakage came. Even in the small area covered by the cofferdam of caissons it was found that six 12-in. pumps were required to handle this leakage. The account of the caisson work, above referred to, describes the methods used to stop this leakage which cut the total water down to a flow that could be handled by one 12-in. pump under half gate.

While this trouble was holding up work at the west end, progress was being made at the east end, and as fast as sections of bed rock were uncovered, concrete was placed to the full height of the dam. The flume was arched over and the dam above the opening completed and thus the work was advanced from both sides. The last section of bed rock was uncovered on April 18, 1911, concrete was brought to water level April 30 and the superstructure completed to crest line on May 14, 1911. The flume was then closed and the opening concreted and then five 10 by 12-ft. sluiceways were closed by gates and concreted, water first passing over the crest of the dam on midnight on May 20.

A Hydraulic Clutch to Replace Friction Clutches.

Numerous attempts have been made to produce hydraulic variable-speed transmission gearing by placing a pump on the driving shaft, a hydraulic motor on the driven shaft and by-passing a part of the flow when variations in speed were desired. This plan was in general unsuccessful because of the high friction loss when the by-pass was brought into operation, giving the poorest efficiency at the time when maximum torque was desired. Recently, however, the by-pass principle has been applied with more success in hydraulic clutches, designed not to give various speed ratios but only to make possible a gradual, positive connection between driving and driven shafts.

An hydraulic clutch of the by-pass type was described recently in a paper by Mr. H. A. Brown,* published in the March "Journal" of the Cleveland Engineering Society. This clutch consists simply of a rotary pump of the eccentric drum type, with the drum keyed to the driven shaft and the outer casing, or cylinder, keyed to the driving shaft. The oil discharged from the pump is short-circuited through a passage cast in the cover plate of the casing from the outlet to the inlet side. When it is desired to transmit power from the driving to the driven shaft, a valve in this passage is closed, and the casing and drum of the pump are thereby forced to revolve together. By closing the valve gradually, the driven shaft can be brought from rest up to the speed of the driving shaft gradually and without shock.

The outer appearance of the clutch is shown in Fig. 1, while Fig. 2 gives a view with cover plate removed, revealing the drum inside the casing. The drum is mounted concentrically on its shaft, while the casing or cylinder is mounted eccentrically on the driving shaft, thus a crescent-shaped space is left between the drum and the casing. The drum is provided with three blades or wings which are kept always in contact with the walls of the casing through being pivoted upon a pin at its center. The blades slide in slots in the periphery of the drum. The slots are cut in short cylindrical pieces (see Fig. 2) inserted in holes at the edge of the drum so as to form rocker bearings which permit a free action of the blades. In Fig. 2 can be seen the ends of the passage through which the oil is short-circuited when the clutch is disconnected. Fig. 1 shows the piston valve used to close this passage and the levers by which the valve is moved. The construction of the pump and valve is shown more clearly in Fig. 3.

*Care Brown-Gates, Engineers, Cleveland, Ohio.

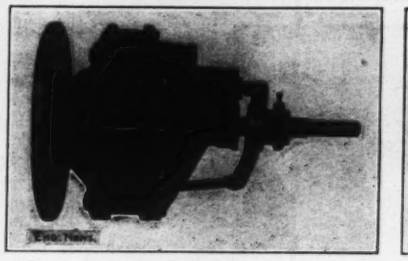


Fig. 1. Assembled, Complete.

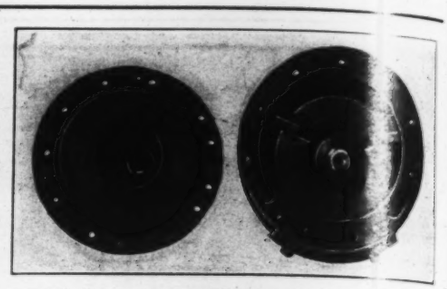
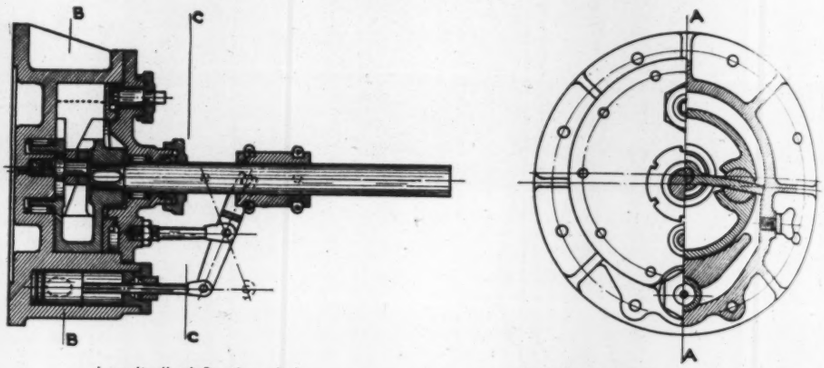


Fig. 2. Cover Plate Removed, Showing Rotary Drum.

FIGS. 1. AND 2. A NEW HYDRAULIC CLUTCH OF THE BY-PASS TYPE.



Longitudinal Section, A-A. Half Section C-C. Half Section B-B.

FIG. 3. SECTIONAL VIEWS OF HYDRAULIC CLUTCH.

Mr. Brown states that the clutch can be used for short periods as a speed-reducing gear when no increase of torque is desired, as for example when a motor car is slowed down due to traffic conditions on a crowded street. In such a case, the by-pass valve could be partly opened, allowing the clutch to slip a little, so to speak, and it would be unnecessary to shift gears. He writes as follows of a practical test of this clutch on a motor car:

> In a recent shop and road test, made by a large local automobile company, a three-blade, 7-in. diameter clutch, similar to that shown in the accompanying photographs, was used on a 30-HP. engine, having a free running speed of 1,000 r. p. m. A heavy cylinder oil was used under a normal pressure of about 1,000 lbs. per sq. in. This was not a new clutch, having seen hard service in a five-passenger, 30-HP. car for over seven months in San Francisco, Cal., and yet it slipped the rear wheels on low gear and stalled the engine on high in the shop test, and fulfilled all the conditions of a road test better than any cone or multiple-disk clutch. This was done with no apparent slippage while positive, nor was excessive heat noticeable when testing its variable speed feature.
>
> During the above test I was present and nothing detrimental was observed except a slight drag when the clutch was thrown out, and as this clutch, being the first one built, is somewhat crude in its construction, it is believed that most of the drag can be eliminated. There is apparently no reason why this clutch could not be adapted to line shafts, hoisting and conveying machinery of all kinds, power boats and in all places where clutches are used. In fact, the controllers of this patent are developing the heavier hoisting-engine type of clutch at the present time, and have incorporated a company to build these clutches for all classes of work.
>
> Regarding the cost of this clutch, as compared with others now in use, it can be said that it is much less expensive, for the cost of maintenance is reduced to a minimum, owing to its frictionless qualities and consequent long life. The initial cost of a hydraulic clutch of small capacity would be about the same as any other, while the cost of the larger ones would be considerably less in comparison, due to the fact that they do not depend on friction to transmit power, and are limited only by the maximum pressure at which oil can be retained in the case.

Notes on Heading Methods in the Loetschberg Tunnel.[1]

By W. L. SAUNDERS.[2]

The records made in driving the headings of the Loetschberg Tunnel (Switzerland) are due to the excellent organization, and to the methods of setting up and taking down the drills.

The type of drill-carriage first used at Loetschberg carried a beam with a counterweight.[3] The carriage now in use at the Loetschberg tunnel was devised by the contractor. In this type the beam and counterweight are omitted, the bar being placed directly on the truck. The width of the tunnel in which these cars can operate varies from 6 to 13 ft.

Each carriage carries four or five drills. Its manipulation is illustrated in Fig. 1. At 1a is shown the carriage, together with the drilling-machines, when brought forward just after mucking the heading. Fig. 1b shows the horizontal shaft swung into position ready for being jacked, and the drills ready to be swung into the position shown in Fig. 1c. It is seen that the drills can be independently swung through an arc of a circle or moved sideways, while in Fig. 1d the different positions which the drills can be given by being swung in a vertical plane are shown.

The time required to change the machine from the position shown in Fig. 1a to that shown in Fig 1c and to commence drilling is usually from 6 to 8 mins. This fact alone shows the superiority of this system of carrying the drills for such work over any other method used up to the present time.

Three kinds of explosives are used. Dynamite with about 85% of nitroglycerine is mostly used in the headings. Westphalite and cheddite, being more safely handled, are used for enlarging and for small blasts.

[1]Extracts from a paper "Tunnel-Driving in the Alps," read before the American Institute of Mining Engineers, June, 1911.

[2]Ingersoll-Rand Co., 11 Broadway, New York City.

[3]Illustrated in Eng. News, Dec. 31, 1908, p. 746, in an article by W. I. Aims, "Methods Employed in Driving Alpine Tunnels: The Loetschberg Tunnel."

Great stress is laid on the fact that a high-grade explosive breaks the rock into small pieces, not larger than an orange, which enables mucking to be done with shovels.

Firing is done with ordinary fuses. The dynamite cartridges are wrapped with red paper in order to be easily detected in case of a miss-fire. Dynamite-carriers and handlers are provided with red lanterns.

Italian labor is used throughout the works with the exception of some Macedonians lately imported. Mostly Italians from the northern provinces of Italy are employed.

A bonus system of payment is used throughout the different kinds of operation. The following wages are paid:

	Daily wages.	Average bonus.	Total.
Drill-foreman	$1.50	$1.10	$2.60
Drill-runners	1.00	0.70	1.70
Muckers	0.80	0.50	1.30
Nippers	0.70	0.30	1.00
Tracklayers	0.80	0.15	0.95
Masons	1.00	0.40	1.40

There are three 8-hr. shifts per day.

As shown in Fig. 2 the width of the finished tunnel-section is 28 ft. at the arch-springing and 25 ft. at the base of the rail. The arch is semi-circular, the crown being 20.7 ft. above the base of rail.

The sequence of excavation is illustrated by Fig. 3. A bottom heading 6.5 by 10 ft. is first driven several hundred feet in advance of the enlargement. Upraises are then driven from 500 to 600 ft. apart, and a top heading started back and forth. The top heading is then enlarged in successive stages.

In the bottom heading the mining operations proceed as follows: The drill-carriage is run forward from its siding close to the face of the heading, passing over 5-ft. by 5-ft. by ⅝-in. steel plates laid on the floor of the heading for a length of about 30 ft. Each plate is provided with 1-in. holes at the corners for ease in handling with a pick.

The water and air pipes laid on one side of the heading to about 40 ft. from its face are connected with the drill carriage, and the drilling begins with the top holes. Water sprinkling is frequently done, especially in starting the holes, in order to lay the dust.

Without interfering with drilling, mucking is going on just behind the drill carriage, and the loaded muck cars are run back to a siding, where trains of from 20 to 30 cars are formed and hauled out by air locomotives.

Drilling being completed in the heading, the drill carriage is run back to its siding, and the steel plates laid on the floor are covered with a layer of muck about 4 ins. thick to prevent deterioration.

The bore holes are then loaded and carefully tamped, and the last man to leave the heading, after firing the fuses, opens the air-pipe valve, the escaping air thus creating a cushion of fresh air from the face of the heading back to a certain distance, so that, after blasting, the muckers are able to go to work without delay.

The bore holes, having an average depth of about 4 ft., are started with a 3-in. drill and finished with a 2-in. drill. On account of giving better results, firing is done with fuses, about 4 ft. long, the center holes being fired first.

Mucking operations proceed as follows: Two empty cars are run to the heading, the first one being immediately loaded by two or three men shoveling without interruption until the car is fully loaded. This operation is performed in 3 or 4 mins., which means that 1 cu. yd. is loaded in from 2.5 to 3 mins.

Owing to the manner of drilling and blasting and to the shallow holes, the muck, instead of piling up in front of the face of the heading, is thrown back, and forms a layer over the floor, which enables the track to be cleared rapidly.

Getting rid of the muck is always a problem in tunnel driving. At Loetschberg a cubic meter car (35.5 cu. ft.) is filled in 5 mins., and it takes only 1 min. to get this car away and bring an empty car to the heading. In order to do this, small entries or chambers are excavated at intervals in the lateral wall of the main heading, which enable an empty car to be thrown from the track on the side, thus clearing the track and allowing the filled car to pass, whereupon the empty car is turned up on its wheels and rolled into the heading. The empty car is brought to the face and filled again in the space of one minute. In one instance, 14 car loads, each of 1 cu. m. volume, were taken away in 1.5 hrs., which cleared the heading completely and allowed the drill wagon to be brought in. Ten men are busy removing the debris; two of this number get at the extreme front of the muck-pile, and their work consists in searching the debris for the dynamite cartridges which might not have exploded. Of the remaining eight men, four work to fill the car, which takes 5 mins.; they then rest for 5 mins., while the second gang of four men come and fill the second car, etc.

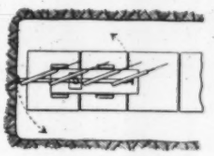


Fig. 1a. Carriage brought forward to the heading face after mucking.

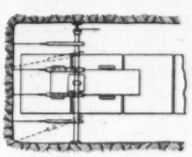


Fig. 1c. Horizontal adjustment of drills.

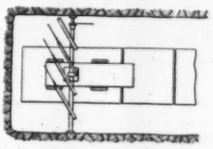


Fig. 1b. Drill-shaft swung around, in position to be jacked.

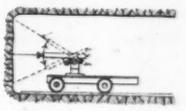


Fig. 1d. Vertical range of drills.

Fig. 1. Settings of the Finally-adopted Drill-Carriage.

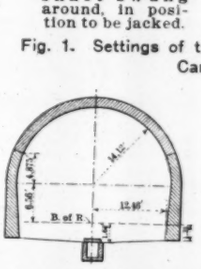


Fig. 2. Standard Section of Loetschberg Tunnel.

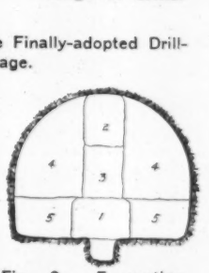


Fig. 3. Excavation Diagram, Loetschberg Tunnel.

Drilling is started not more than 5 mins. after the removal of the last carload. This result, which at first sight seems impossible, is only obtained by absolute discipline.

The man who knows that his only work at this moment is to connect the air main to the drill carriage does not do anything else; the men whose duty it is to screw the carriage tightly to the wall immediately jump to the right place.

The rate of drilling is, 15 or 16 holes in 1.1-1.15 hours.

An engineer who recently visited this work says:

When I arrived at the heading it was 9.30 a. m. The holes were being prepared for blasting. The blast took place at 9.35 a. m.; 5 mins. after the blast the men were in place removing the debris, and at a little after 11 a. m. the drill carriage was in place again and the rock drills were working. It usually takes from 25 to 30 mins. between the time at which the drilling is finished and the time at which the start is made to remove the debris; that is to say, 25 mins. for taking away the drill carriage, cleaning the holes, loading with explosives and blasting. An additional 5 mins. are consumed in getting the smoke away by means of the ventilator and then the men get to work at the debris. In order to assist the men a spray of water is discharged near the heading after the blast. This water is brought into the tunnel in a pipe placed within a larger pipe, which insulates it and keeps its temperature from being affected by the temperature of the tunnel.

Drilling in the top heading is accomplished by means of two or three drills carried on tripods or on a horizontal bar, while hammer hand drills are used generally for the enlargement.

Mucking operations in the top heading are very simple, since all blasted material is dumped directly through the upraises into cars running on a siding in the bottom heading.

The operations of blasting, mucking, timbering, and hauling are performed without interruption and without interference with each other, and a special force of engineers is required in order to obtain such a result.

All employees and workmen are insured against accident or death, by the contracting company, and great care is therefore exercised in handling explosives and in operating the trains.

Ventilation in the tunnel is obtained from two ventilators 11.5 ft. in diameter, having a capacity of 53,000 cu. ft. of air per min. at 5.5 oz. pressure. Each ventilator is belt-driven by a 175-HP. electric motor, housed in a building at each portal, forming part of the permanent ventilation system.

Air is taken in that part of the tunnel already completed through a canal of 68 sq. ft. area, made of hollow tiles, then through steel pipes to electric-driven ventilators running in series, and having a capacity of 6,300 cu. ft. of air per min. at 14 oz. pressure. These two ventilators are mounted on carriages, and are moved along as the work advances.

Openings are provided at intervals in the above-described air canal so as to allow part of the air to escape in the tunnel.

In comparing conditions on the north and south ends of the Loetschberg tunnel, it is well to bear in mind that at the south end the rock is generally harder and the temperature higher. At the north end the temperature varies from 75° to 80° F., while at the south end it has reached a maximum of 110° F. It is also claimed that a remarkable organization of the working force exists on the north end. The settlement at the south end was built by the Loetschberg Co. The winter there is extremely severe and dangerous. Three years ago, by an avalanche, seven men were killed, among them an American engineer named Merwarth, who was at the time installing the compressed-air machinery. Conditions of this kind do not favor the contractor in getting the best kind of labor. Kandersteg, at the north end, is practically a summer-and-winter resort, full of good hotels, easy to reach, and a more favorable labor market.

At one time, when the north heading was making a daily progress in excess of the south heading, the contractors sent some of the drills from the north heading over to the south, thinking that perhaps the difference in progress was due to the drill, but the results were not changed. It seems plain that, were it a question of machinery only, the machinery making the greater progress would be used throughout, but the difference appears to be one of natural conditions and of organization.

The official reports show that the quantity of air used for ventilation on the southern end was only about half that on the northern end, and it is generally said that the southern ventilating system was not as effective as the northern, whereas the temperatures on the southern

LOETSCHBERG TUNNEL PROGRESS SUMMARY, 1908-1910.

(Condensed summary of table given by Mr. Saunders, whose figures are from official reports of the Berner Alpen Bahn.)

	1908.		1909		First half of 1910.	
	North end.	South end.	North end.	South end.	North end.	South end
Progress of heading, ft.	4,108	5,682	7,550	5,772	4,740	2,950
Av. cross-section of heading, sq. ft.	65.60	64.52	73.0	67.6	69.2	64.6
Heading excavation, cu. yds.	9,672	13,755	19,842	14,410	12,100	7,100
Number of rounds	1,074	1,648	1,609	1,670	1,157	724
Av. progress of one round, ft.	3.95	3.51	4.55	3.62	4.1	4.07
Drilling time per round, hrs.	1.27	1.40	1.12	2.17	1.15	2.40
Mucking time per round, hrs.	2.30	3.00	2.33	2.53	7.10	3.00
Total time of one round, hrs.	4.22	4.58	4.08	5.18	3.36	5.47
Number of holes per round	12.6	11.8	14.3	13.3	14.5	14.15
Av. length of one hole, ft.	4.33	4.33	4.87	4.32	4.66	4.56
Feet of hole per cu. yd.	5.72	5.92	5.74	6.44	6.48	6.62
Dynamite per cu. yd., lbs.	6.28	6.17	5.48	7.48	6.53	6.98
Number of steel bits per cu. yd.	1.96	2.26	0.72	5.38	3.57	6.62
Air pressure at face, lbs. per sq. in.	99.3	78.1	100.8	65.9	110	81
Temperature at face, degrees F.	53.2	76.	58.3	81.8	62.8	85.2
Rock temperature at face, degrees F.			55.1	83.2	60.8	91.4
Nature of rock	[1]	[2]	[3]	[4]	[5]	[6]
Remarks	[7]	[8]				

[1]Limestone generally to point of cave-in. [2]Various gneisses, some chloritic and sericitic. [3]Varying; limestone, Trias malm. [4]Varying; limestone, slate, granite, porphyry, etc. [5]Gastern granite. [6]Granite and quartz porphyry. [7]Cave-in July 24, 1908; no heading work during remainder of year. [8]Avalanche accident.

end were higher. The operating force was compelled to use compressed air from the air mains to increase the ventilation, and it, in a measure, reduced the temperature, thus decreasing the pressure used for drilling. It is likely that in this way the efficiency of the drills may have been somewhat reduced. The working pressures were: north end, 7.2; south end, 5.2 atmospheres.

The nature of the rock was different on the two ends of the tunnel. An average of one steel was required in the north end for 1 cu. m. of excavation, while on the south end an average of from 5 to 7 was required for the same work.

The average consumption of steels for 2.5 years was: north end, 2.33; south end, 7.70 steels per cu. m. driven.

The report for the year 1910 shows that in the first part the rock encountered on both the north and south ends was practically the same, although the average drilling time was much less on the north than on the south end. To explain this, the air pressure on the north end during this period was 7.75, as compared with 5.7 atmospheres on the south end, which largely accounts for the difference. It must also be noted that the number of steels per cubic meter of rock removed was, on the north end, 4.65; and on the south, 8.61, which indicates either that the effect of the rock on the drill bits was different, or that the blacksmith work was unequal.

Conveyors for Foundries.

By HENRY J. EDSALL.*

Great advances have been made in recent years in "modernizing" shops of various kinds. These advances have included the development of special machines for various operations, the improvement of the general arrangement of plants and the adoption of improved methods of handling the various materials and articles of manufacture. One of the last shops to be improved was the foundry, though it really deserved to be among the first considered, not only because making the casting is one of the earliest operations in the manufacture of numberless machine parts and other cast-metal objects, but also because there were and still are so many possibilities of improvement in foundry methods.

One of the notable improvements in foundry equipment is the molding machine, which is designed to simplify and expedite the work of the molder, so that with the aid of the machine one man can do the work of many and do it more accurately and uniformly. In fact, some of the machines practically do the entire work of molding and pattern drawing, and all that is required in the way of attendance is an operator to feed sand to the machine and work the valves or levers, while either the same man or others remove the finished mold and insert in its place the parts of an empty flask.

With these machines a large amount of sand is used and a great number of molds made at one point, instead of having the work distributed over a large molding floor. This naturally suggests the possibility of saving labor by taking the sand to the molding machines with conveyors and either collecting it again from the pouring floor, by means of conveyors, or taking the molds, after they have been poured and allowed to cool, to a fixed point at which the sand can be shaken out and delivered back to the conveyor system.

As a matter of fact, this not only saves labor but in many cases is the only way that molding machines can be kept up to their proper output, since they use so much sand and the space around them is so limited that it is practically impossible to feed the sand to them rapidly enough by hand labor. This means that without sand and mold conveyors it is impracticable to keep the output of expensive automatic machines up to what their cost and capabilities demand. Even more is possible in the case of the simpler one-man machines per pay roll capita; for example, such a machine making molds at the rate of 20 per hour with its single operator shoveling the sand, readily makes from 60 to 80 per hour when the operator is relieved of shoveling sand and carrying molds away. This, therefore, is one of the commonest uses for conveyors in foundries. Such a sand-handling system may in some cases be quite simple and comparatively inexpensive, and in other cases quite elaborate, depending on the requirements.

The chief uses for conveyors in foundries may be enumerated as follows:

1. Unloading coke from cars or boats and delivering either to storage bins or to the charging floor, or for transferring from storage to the charging floor.

2. Handling pig iron and scrap from cars or boats to a storage place, or to the charging floor; or for transferring from storage to the charging floor.

3. Handling sand from cars or boats to storage bins, or to foundry floors, and taking from the bins and delivering to foundry floors.

4. Handling burnt sand cleaned from castings. Part of this sand is usually added to fresh sand and used over again. In some cases it is elevated to an overhead bin, from which it can either be taken out to mix with fresh sand, or delivered to carts or cars for disposal elsewhere.

5. Carrying finished molds while they are being poured and while they are cooling.

6. Conveying castings from one place to another.

7. Conveying various kinds of pieces through finishing operations, such as galvanizing or washing the oil and chips from pipe fittings after tapping.

Coke Handling.

Foundry coke requires good-sized conveyors to handle it satisfactorily because of the large pieces. On account of the friction of the pieces on each other and their irregular shape, it will pile at quite a steep angle and will choke up in even a good-sized discharge opening, instead of flowing or sliding through it like coal. There has been very little attempt, therefore, to unload it automatically, as it would require a good deal of labor to get it out of any of the standard drop-bottom railway cars. Quite a large part of the coke is shipped in box cars and this necessarily means taking it out by hand. Coke is, moreover, hard and abrasive so that machinery for handling it must be very carefully designed in regard to resisting wear.

In elevating coke the usual type of machine is a double-strand elevator with steel buckets attached between the chains at intervals of about two feet. These buckets should be not less than 20 or 24 ins. long. The best chain to use is either a first-class malleable-iron roller chain with little chance for the grit to get into the joints, or a chain with case-hardened steel bushings and pins. The buckets are usually attached to the chains by means of a swiveling attachment to allow for unequal stretching, and guides are provided to keep the chains from swinging. At the loading point a small feeding hopper or chute is provided, into which the coke is forked or shoveled, and a casing is built close around the ascending buckets so that the coke necessarily goes directly into them. In order to get a proper discharge with a vertical elevator the "perfect discharge" type is usually used, in which the hold-back wheels, just below the head wheels, bend the descending chains back so that it is possible to get a chute well back under the bucket as it turns and starts to go down. Frequently the elevator is vertical for part of the lift and then runs off at an incline so as to reach the center of the bin or thereabouts. In such cases roller chains should always be used and tracks arranged on the inclined part for the rollers to run on. The speed of these elevators is usually between 50 and 100 ft. per min., and even at such a slow speed they will usually more than keep up with two or three men feeding coke to them, on account of the large buckets.

Where considerable coke is to be stored, it is customary to arrange for several discharge points, instead of one, so that beter distribution can be obtained. This can be done by making the elevator higher and having two or more chutes to distribute the coke in the bin. A better way, as a rule, is to run a horizontal distributing conveyor, which receives the coke from the elevator and discharges it at various points along the bin. Such an installation is shown in Fig. 1. Belt conveyors are about the only type that are satisfactory for this purpose. The coke rides along on the belt without any scraping or sliding and can be discharged by means of a stand tripper at any point along the belt except close to the ends. The idlers of a belt conveyor are internally oiled, so that there is a tendency to force the grit out and avoid excessive wear. These idlers last very well under severe conditions and a good belt also lasts well if properly taken care of. Rubber belts with an extra layer of rubber on the carrying side are ordinarily used. It is best to locate the conveyor in a monitor which can be lighted by windows in the sides and along which it is easy to build footwalks for the convenience of the operator in moving the tripper and looking after the grease cups. This also allows the coke to be piled all the way up to the peak of the main roof, thus taking advantage of nearly all of the space available.

The power cost for handling coke with conveyors is small, not over two or three cents per ton ordinarily. The labor cost involves the wages of a man to look after and operate the conveyor, the labor of getting the coke out of the cars and to the conveyor and any trimming that may be required to more completely fill the storage bin.

Handling Pig Iron and Scrap.

Pig iron and scrap are usually unloaded from cars or boats by hand, or by means of a crane equipped with an electro-magnet, and are either stored close by or loaded into an industrial car or wheelbarrow and taken directly to the charging floor or to the desired storage space. In some cases, however, it has been found advantageous to use an elevator, conveyor or carhaul to take the pig and scrap iron to the charging floor or storage space. One type of elevator used consists of a single strand of chain running over sprocket wheels at head and foot, with angle irons attached to the chain at intervals to form shelves on which the pigs are placed. The chain is run at a slight incline and slides on guides on the elevating side. The pigs are placed on the shelves by hand and discharged over the head wheel into a chute leading either directly to the charging floor or to a wheelbarrow or car. The elevator shown in Fig 2 is rigged with additional slides to take a box containing coke or scrap iron, the angles on the chain pushing the box up the incline.

A carhaul is a convenient way of taking a small car loaded with coke, pig or scrap iron, up to the charging floor. The car can be loaded at any point and pushed by hand to the foot of the haul, where hooks attached to a moving chain engage with the car and push it up an inclined track. The car can be automatically lowered by means of a return haul, if desired.

Sand Handling.

When sand is received at a foundry, either by rail or boat, it is necessary to unload and deliver it to bins or to a storage space in the yard. If it is shoveled or wheeled in wheelbarrows, it is hard to pile it satisfactorily without a great deal of useless labor. It is usually found to be advantageous, therefore, to use some mechanical method of handling it to the pile or bin. A simple chain-and-bucket, or belt-and-bucket, elevator will elevate the sand and discharge it into one or more bins by means of chutes; or with the addition of a distributing conveyor or car it can be distributed to bins located where most advantageous, or heaped in a pile of considerable length and a greater amount thus stored at small expense for handling.

Chain elevators for this purpose are, as a rule, of the single-chain centrifugal-discharge type, the buckets throwing the sand out into a chute as they pass around the head wheel. The best type of chain to use is of malleable iron with case-hardened steel pins and bushings and ample bearing surface in the joints. The "Ley" bushed chain is of this type and has the malleable iron barrel of the link made in such a way that the under part of the bushing is exposed, so that the sprocket wheels engage with the bushings instead of coming into contact with the frame of the chain. Such a chain, in connection with sprocket wheels having hard, chilled faces, will last remarkably well handling a gritty material

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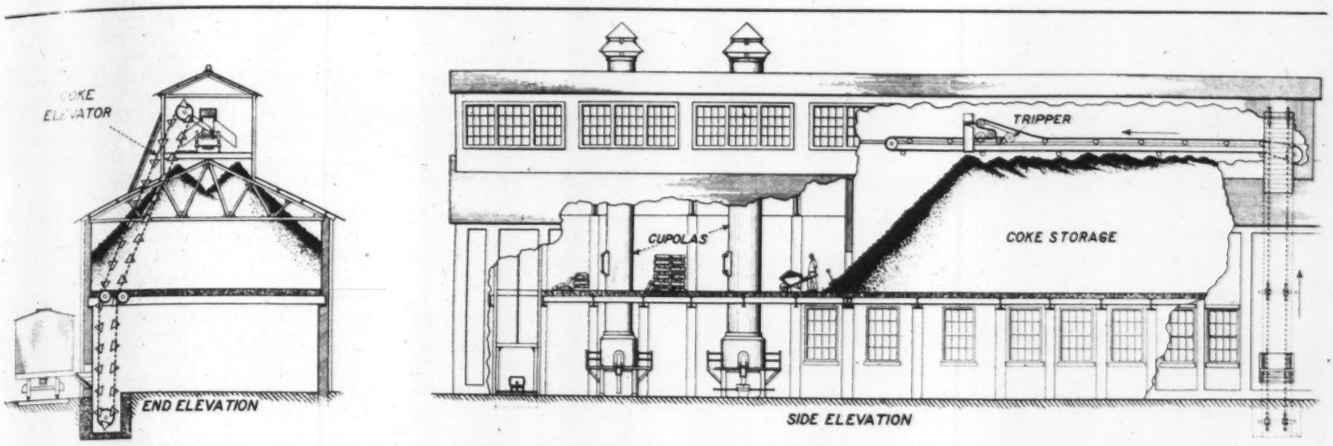


FIG. 1. COKE ELEVATOR AND DISTRIBUTING CONVEYOR AT THE FOUNDRY OF THE SHARPLESS SEPARATOR CO., WEST CHESTER, PA.

like sand, and when the pins and bushings become worn they can first be reversed to bring the wear on the opposite side and then renewed at comparatively small expense without renewing the main frame of the link.

In some cases the chain is replaced with a rubber belt, to which the buckets are riveted, and which runs over pulleys at head and foot. This makes an elevator that is somewhat cheaper in first cost, but which will not last nearly as well, and one that is more subject to delays by having the buckets torn from the belt when they come in contact with foreign substances in the sand. The belt is also apt to slip on the pulleys if the sand is quite damp.

A rubber belt conveyor is a good machine for conveying sand, providing that there is only one delivery point, this being the discharge over the end of the conveyor; and it works very well for handling sand on an incline when the angle is not over 20° It can also be used for distributing sand, if a tripper is used for discharging at the various points, but this means running the carrying face of the belt against the turn pulley of the tripper and some sand is apt to stick to the belt and cause too rapid wear, as it will be ground into the belt by the pulley.

The best type of machine for distributing sand at various points is the reciprocating conveyor. This type of machine has a main rod or frame supported on rollers spaced at intervals of several feet and with hinged plates, called flights, attached to the under side of the frame at intervals of a foot or so. A crank and connecting rod give a back-and-forth, or reciprocating, motion to the frame so that the flights are moved forward and then back. As they go forward, they push the sand with them, and as they come back, the hinge allows each one to lift up and drag back over the little pile of sand directly behind it. Thus a new pile of sand is gotten in front of each flight ready for the next push forward. Such a conveyor has few wearing parts and most of these are well up out of the sand or can be well protected.

The rollers are spaced ordinarily at intervals of about 8 ft. and run on tracks at the side of the trough, along which the material is conveyed. The hinges, being at the top of the flights, are not much affected by the sand and are of such simple design that a little wear does not hurt them. The trough is usually made with considerable clearance for the flights so that there is always a bed of sand underneath the flight to protect the bottom of the trough, and little actual rubbing of the sand against its sides. The discharge from this kind of a conveyor is obtained by simply putting gates in the bottom of the trough at the desired points, the sand falling through the first open gate. It is possible to discharge at several points at the same time by arranging sliding gates so that they need not be opened wide and thus, by opening each one only

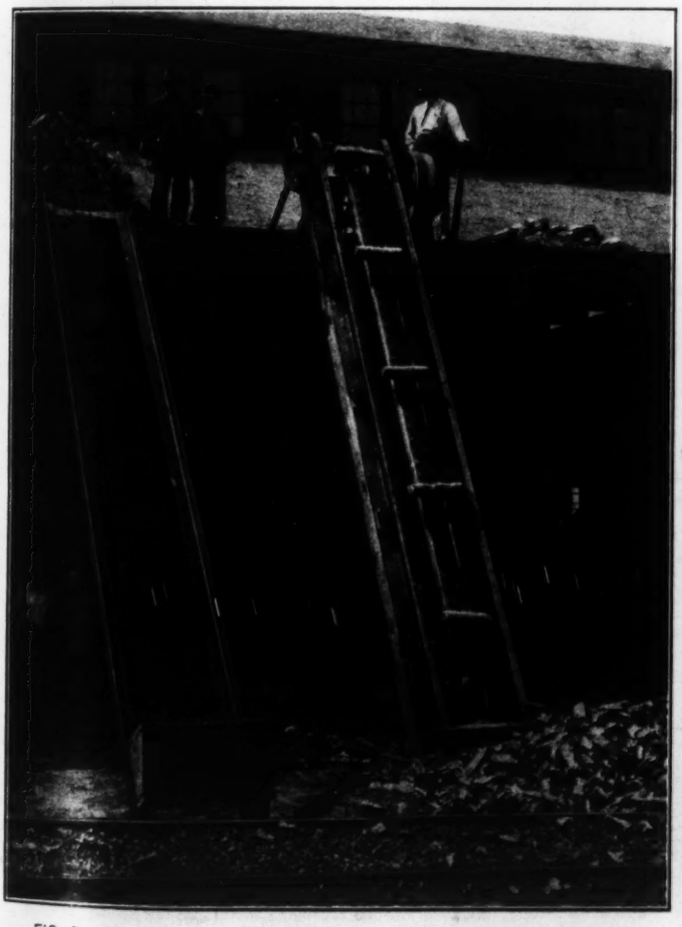


FIG. 2. PIG IRON ELEVATOR AT THE TACONY IRON CO.'S PLANT IN PHILADELPHIA, PA.

FIG. 3. A TRAVELING HORIZONTAL POURING TABLE AT THE WORKS OF THE WESTINGHOUSE AIR BRAKE CO., PITTSBURG, PA.

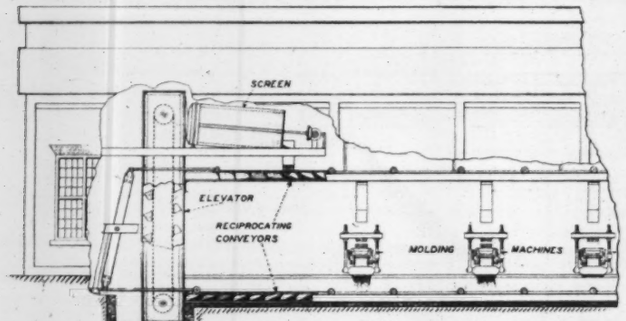


FIG. 4. BUCKET ELEVATOR AND RECIPROCATING CONVEYOR SYSTEM FOR SAND-HANDLING.

(The surplus sand from machines goes direct to conveyor under the floor, and sand shaken from molds is also fed back to this conveyor.)

part way, only part of the sand is discharged at each point.

The combination of a vertical, centrifugal discharge, chain elevator and a horizontal reciprocating conveyor is an excellent one for elevating sand and distributing to storage bins, or for delivering to several feeding hoppers or chutes over molding machines, as shown in Fig. 4. The surplus sand, "struck off" from the flasks after they are filled, can be returned to the foot of the elevator by means of a belt or reciprocating conveyor, running below the floor and with gratings over it through which the sand can be fed. Sometimes the molds, after they are poured and allowed to cool, are broken up on gratings over a sand conveyor, so that the sand goes through into the conveyor to be taken back to the elevator and thence through the distributing conveyor to the hoppers over the molding machines. The flasks and castings remain on the grating and can be removed as desired. When sand is to go right back from the poured molds to the molding machines, some provision must be made for cooling, sprinkling with water and getting it tempered and again into good molding condition.

Burnt sand, or sand that has been more or less affected by the heat in casting, is handled by the same types of conveyors as fresh sand. This sand is usually elevated to an overhead storage bin, from which it can be drawn out to carts or railroad cars, or fed to a mixer or pan grinder for mixing with fresh sand and using over again. Since this sand is apt to contain considerable iron in the form of nails, small pieces from splashes of molten metal, etc., it is well to put it through a magnetic separator and screen before it goes to the elevator, so as to save the iron and get rid of other foreign substances.

Sometimes the burnt sand is first delivered to a conveyor, which conveys it from one or more points in the foundry to the magnetic separator at the foot of the elevator. Such a conveyor is used when it is not possible to locate the elevator at a convenient point for feeding the sand to it; or when it is desired to get rid of the necessity of either shoveling the sand up into the magnetic separator or dropping the magnetic separator and the foot of the elevator down lower. The conveyor can be run on an incline so as to keep the feeding point down low and yet get the sand up to the proper level for delivery to the separator. In some plants the sand is brought to the conveyor in a box or bucket handled by an overhead crane, and a feeding hopper is arranged so that the bucket can dump the sand into it in quantity. An automatic feeder regulates the feed to the conveyor.

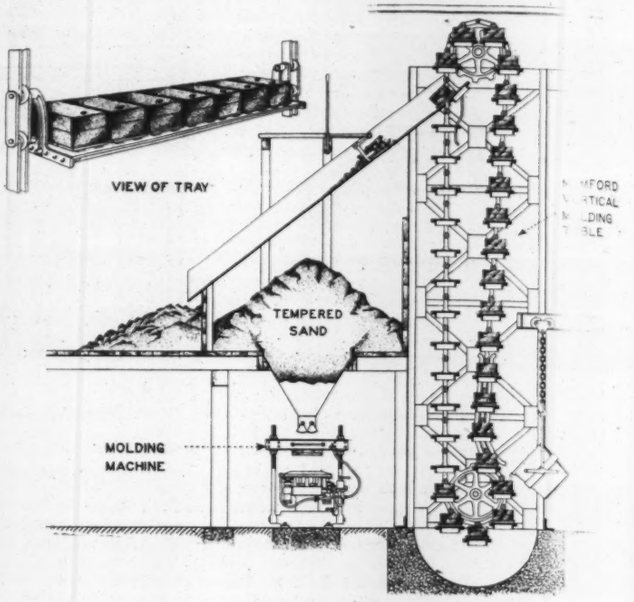


FIG. 5. THE MUMFORD VERTICAL MOLDING TABLE.

Mold Conveyors or Traveling Pouring Tables.

Where continuous pouring is practised in connection with molding machines, a conveyor for carrying the molds while they are being poured and allowed to cool is almost indispensable, and some of the systems so equipped, one of which is shown in Fig. 3, are wonderfully complete and economical.

The horizontal pouring table consists of a continuous series of tables on wheels and attached to a chain operating around sprocket wheels set in a horizontal plane. As the sprocket wheels revolve, the chain moves the tables along usually at a speed of about 30 ft. per min. If the tables are each 3 ft. long, this means ten tables per minute passing any given point. The molding machines are lined up along a section of the pouring table, and as soon as a mold is completed, it is placed on one of the tables. Just beyond the molding machines is the pouring space where the ladle men pour the metal into the molds as they move along. The poured molds then travel the rest of the way around until they come to a shake-out place just before the molding machines are again reached. By this time the castings are cooled sufficiently so that the molds can be pulled off and broken upon a grating. The sand goes through the grating and into the conveyor system and the flasks and castings are removed and either taken away by hand or placed on conveyors, the castings to go to the cleaning department and the flasks back to the molding machines.

The sand shaken out is elevated, passed through a rotary screen and then to the conveyor leading to the molding machine chutes. Just as it goes into this conveyor it is sprayed with water, and as the amount of water supplied is a very important part of the sand preparation this spray has to be carefully regulated. The best way to accomplish this is to make it one man's sole duty to see that this water supply is kept properly regulated so as to give the best results. A magnetic separator is also a usual part of such a sand-handling system, and in some cases it is found necessary to pass the sand through a pan grinder or sand mixer, or both, in each trip around the system. It is necessary to give the sand time to cool and temper properly before it gets back to the molding machines, and this can be accomplished either by providing sufficient storage at some point in the cycle or by carrying it farther in the conveyors at as slow a speed as is feasible with the carrying capacity required. Sometimes the sand is carried beyond the molding machines and brought back on another conveyor so as to avoid the necessity of a larger storage than is furnished by the hoppers over the molding machines, and for the additional reason that the sand has a better chance to cool when spread out on the conveyor.

One of the latest refinements in connection with a system of this kind is to use a moving platform on which the ladle men stand when pouring the molds. This platform carries them along at the same rate at which the molds move.

A pouring table with 3-ft. tables, moving at a speed of 30 ft. per min., is capable of handling ten molds per minute, or 600 per hour, and with such a table there should be enough molding machines to give about this output. It is also possible to make the tables double so that each table will carry two molds. In this case the molding machines would be lined up on both sides of one line of tables and the molds placed on both sides of each table. A continuous system like this tends to keep the output regular, since the pace is set by the capacity of the pouring table and the men on the molding machines are apt to keep up to it. Enormous outputs are obtained in some foundries in this way with remarkably few men and working comparatively short hours.

Recently Mr. E. H. Mumford* has brought out a new type of pouring table which he calls a vertical mold table. This machine (see Fig. 5) carries the molds up vertically on shelves or

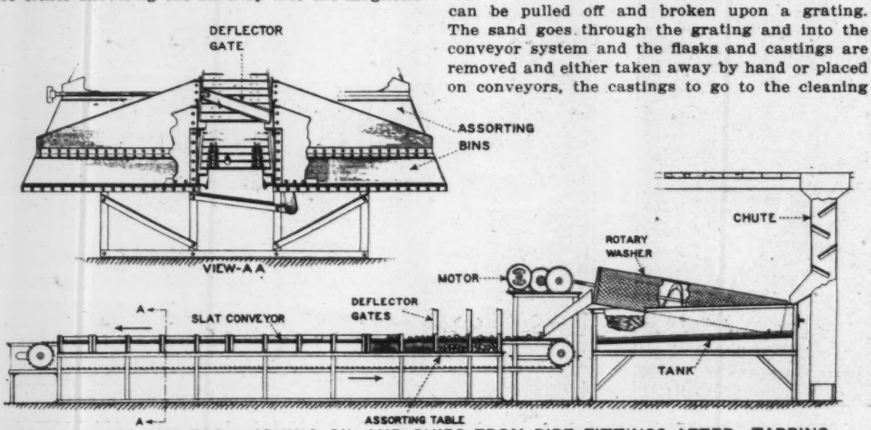


FIG. 6. MACHINE FOR WASHING OIL AND CHIPS FROM PIPE FITTINGS AFTER TAPPING.
(Installed at plant of the Thomas Devlin Manufacturing Co., Burlington, N. J.)

*Vice-President and General Manager of the Mumford Molding Machine Co.

trays suspended between two vertical chains which pass around sprocket wheels above and below. The trays are pivoted by having hangers at each end which hang from pins extending out from the chains. This allows the bottoms of the trays to keep their horizontal position throughout the full path of travel. The molding machines are located close to the foot of the mold table, and as the molds are completed they are placed on the descending trays, possibly several to a tray. The pouring is done just after the trays have passed around the foot wheels and started to ascend. The chains are bent in at this point by means of guide rails, so as to move each tray back after it has been poured and give better access to the molds on the tray next below. The molds have time to cool while completing the ascent and traveling around the head wheels, and as the trays start to descend they are tipped by guides so as to slide the molds off into a chute. The sand then passes through a grating and collects on an elevated platform, or second floor, where it can be tempered, cooled and fed through a chute back to the molding machines. The bottom boards and the flasks, if they have been sent up with the molds, can be delivered down a chute to a point convenient to the molding machines, and the castings can also be sent down a chute to the first floor or conveyed to any desired point.

If the output does not justify continuous pouring, one or more mold tables can be used for storing the molds made in the early part of the day and molding can be continued while the pouring is being done, thus obtaining a large daily output with a minimum amount of labor in handling molds, sand, flasks and castings. A machine of this type, with room for several molds on each tray, would necessarily be run at a very slow speed to allow time for the molds to be made and placed on the trays, or else the trays would travel all the way around more than once before they received their full load of molds, and in this case the dumping device at the top would have to be thrown out of service while the trays were being filled up preparatory to pouring.

A vertical mold table, with the trays spaced 2 ft. apart and traveling at a speed of 2 ft. per min., would have one tray per minute passing a given point, and with room for seven molds on each tray it would be capable of taking care of seven molds per minute. A machine of this kind, 25 ft. c. to c. of head and foot shafts with 36-in. sprocket wheels, would have about 60 ft. in each chain. This would mean 30 trays with a storage capacity for 210 molds.

Among the advantages claimed for this type of machine is the comparatively small amount of floor space required to take care of a large number of molds, and as the sand is delivered to the second floor it does not take up space on the main foundry floor and it is at the proper level for delivering to the chutes leading to the molding machines. This type of mold conveyor, therefore, serves also as a sand elevator. Little power is required for operating such a mold table, for though the weight on the machine may be considerable, the speed is very slow and the up-and-down sides of the machine balance each other except for the excess weight of molds that may happen to be on one side or the other.

Fittings Washing Machine.

When pipe fittings are tapped with a stream of oil playing on the tap, they become coated with oil and retain a good many chips cut out by the tap. To get rid of the oil and the chips they are commonly washed in a soda solution. In order to do this rapidly and economically, a machine has been devised which turns them over and over in the solution and then delivers them to a steel apron conveyor, from which they can be discharged into separate boxes or compartments. An installation of this sort is shown in Fig. 6.

The washer consists of a revolving cylinder having an internal spiral blade, and set at an incline so that the lower end extends down into a tank containing the soda solution. The fittings are usually collected in boxes at the tapping machines and dumped, a boxful at a time, into a chute leading to the lower end of the revolving cylinder. As this cylinder revolves, they keep turning over and over and climbing up the spiral, so that they finally come out at the upper end and drop on the apron conveyor. This machine consists of a continuous series of steel slats attached to two strands of chain. At one or both sides of this conveyor are the boxes or compartments for receiving the fittings, and steel scrapers or plows are arranged so that they can be thrown into position over the conveyor to scrape the fittings off into any box desired. In this way the machine is used to sort the fittings and deliver them to the proper boxes, as well as to wash them. It does the work rapidly and economically.

Choosing a System.

The instances described will give some idea of the possibilities of saving labor and expediting the work by the use of conveyors in foundries, but every problem of this kind has its own special features and requirements and therefore each case usually requires special treatment and design in order to get the best and most economical equipment. The solving of these problems is best done by the conveying-machinery engineer working in conjunction with the practical foundry operator, the former knowing the possibilities and limitations in using conveyors and the most suitable types of machines, and the latter furnishing the necessary data in regard to the work to be accomplished and the limitations from the foundry man's point of view in the methods to be used in accomplishing it. In this way there have been some remarkably complete systems worked out that have proved to be great labor savers.

Water Waste and Water Famine in Dallas, Texas.

The city of Dallas, Tex., has recently passed through an experience so harrowing that it is not likely to be repeated, at least in the present generation; and so illuminating that other cities may profit by its consideration. The general public is not easily impressed with the necessity of water conservation so long as water continues to come through the house taps; and the introduction of water meters is opposed, even by no less an authority than the mayor of America's largest city, on the ground that a water supply should be made inexhaustible!

In spite of the water famine which has for months threatened New York City, water waste in private households went on unchecked. In Dallas also water waste went on unchecked, with the result that after two exceptionally dry years the people suddenly realized that their entire water supply was practically exhausted, and desperate measures were necessary to keep water enough in the mains to provide any kind of fire protection, let alone furnish water for domestic use.

Dallas is a thriving manufacturing city whose population has increased from 43,000 in 1900 to 100,000 in 1910. It was one of the first cities to adopt the commission plan of city government. Its water-works were purchased by the city from private owners in 1881, and furnish water to nearly all the built-up sections of the city, with the exception of Oak Cliff, which was formerly an independent city and has its own water-works, supplied by two deep wells.

The entire supply of the city proper is obtained from an impounding reservoir at Record's Crossing on the Elm Fork of the Trinity River, having a capacity of 200,000,000 gals., and another impounding reservoir on Bachman's Branch, a tributary of Elm Fork, having a storage capacity of 700,000,000 gals. From Bachman's Reservoir the water runs by gravity through a conduit to the Turtle Creek Reservoir in the northwest corner of the city. Water from the Record's Crossing Reservoir is pumped into the same conduit from a pumping station at Record's Crossing. The Turtle Creek Reservoir is the distributing reservoir for the whole city and holds about 133,000,000 gals. Water is pumped from here into the distribution system, which is in one service, with a standpipe acting as an equalizer.*

The average annual rainfall for 14 years up to 1909 had been 35.82 ins. In 1908 the water at the Record's Crossing pumping station was so high that the pumps were submerged and the boiler flooded to the firebox. But the total rainfall during the two years 1909 and 1910 amounted to only 40.9 ins., only 60% of the normal amount. Meanwhile water waste went merrily on. With over 18,000 house connections only 21 meters were in use in the entire city. The average daily consumption per capita increased from 87 gals. in 1905 to 115 gals. in 1909, and during June, 1909, ran as high as 157 gals. per capita.

In 1907 the city had voted bonds for an increase in supply, but apparently work was not pushed very rapidly. These new works include a pumping station at Bachman's Reservoir to pump water from Elm Fork into this reservoir, from which it will flow by gravity into Turtle Creek Reservoir. A new storage reservoir is under construction at White Rock Creek, which will have a capacity of 6,000,000,000 gals. A pumping station to be erected here will pump directly into the city mains.

But these prospective additions were of no avail to help the city until their completion. The actual available supply continued to diminish until in the summer of 1910 the authorities were compelled to restrict the domestic use of water. By September affairs became very serious. The Elm Fork reservoir at Record's Crossing had become practically exhausted. A few weeks later, early in November, the Bachman's Reservoir was nearly dry. The use of water was then further restricted by cutting off all the large consumers possible, and by reducing the pressure at the Turtle Creek pumping station until only 18 to 20 lbs. was maintained for domestic service.

At this time an investigation was made of the Dallas situation by the engineers of the National Board of Fire Underwriters, and both these reservoirs were found practically empty, with no water flowing into them. The only supply from Elm Fork was obtained by ditching from pools in the stream bed, the water thus collected being pumped into Turtle Creek Reservoir by a temporary plant established for that purpose. From this source, and by pumping from five artesian wells, a supply of 3,000,000 gals. per day was obtained, whereas the average daily consumption of the city in June, 1910, had been 15,000,000 gals. The total amount of available water in the Turtle Creek Reservoir was then 20,000,000 gals. This supply permitted a pressure at the pumping station of only 18 or 20 lbs., and large sections in the eastern and northern parts of the city were entirely without water. The pressure in the mercantile district ranged from 0 to 10 lbs. per sq. in.

The danger from fires at this time was very great. Records of fires during this period showed serious delays in getting a material increase in pressure. In some cases no water was available when the apparatus first arrived. In one large fire 22 minutes elapsed before water could be got from the mains. During this investigation by the insurance engineers many street mains were found to be empty and great numbers of house fixtures were left open to catch the first supply of water that should come into the mains, thus overburdening the pumps when the pressure was raised for fires.

Emergency measures were now taken. A 6-in. surface main was laid through the business district to the Trinity River, and connections made with two centrifugal pumps, to be operated on signal for furnishing water for fire engines. Artesian wells were hurriedly sunk by the city and by private interests. Numerous dams were constructed on Mill Creek and Dallas Branch, small streams which flow through the residential part of the city, with which to impound water for fire protection. Several galvanized-iron tanks, of 11,000 gals. capacity, were set up in the residential sections and filled from private wells, to be used for fire fighting in case of an emergency.

*From data published by the National Board of Fire Underwriters.

Two extra men were placed at each fire station, and the police force was increased one-third and their patrol duties, especially those with reference to fires, were made more exacting. At this time water was cut off from house connections and delivered by the city in wagons, each day's supply to be carefully husbanded in tubs. The people were beginning to appreciate the meaning of a water famine.

The first six months of the present year passed without relief by the rains. The total rainfall for the month of May was only 0.46 in., compared with an average for the same month in previous years of 4.50 ins. At the same time the mean monthly temperatures ranged from 1° to 10° higher than normal. On June 3 there was no water whatever flowing in Elm Fork, from which two years before all the water supply of the city had been obtained. Water was still obtained from sink holes in the bed of the stream and from wells. At this time another inspection made by the National Board of Fire Underwriters found but 15,000,000 gals. in the Bachman's Reservoir and 50,000,000 gals. in the Turtle Creek Reservoir. The average daily supply since December had been between 5,000,000 and 6,000,000 gals. per day; and water for domestic purposes could be drawn only during the hour 6 A. M. to 7 A. M.; at all other times the home services were disconnected.

During these six months the well-boring had been kept up half-heartily, for rain was still constantly hoped for to help the city in its extremity. Three temporary dams were built on Elm Fork above Record's Crossing, and a permanent concrete one begun on the same stream, to catch the long-expected flood when it should come. Fifteen inspectors were constantly employed to reduce not only water waste but water consumption to a minimum. Ten more permanent men were added to the police force, and police and sanitary inspectors were instructed to report all wasteful consumers. A large appropriation was made for the purchase and installation of water meters, and it is now hoped to have every house connection metered within the next three years. Since Nov. 1, 1910, the fire department has been increased by 19 men, 2 automobile combination chemical engines and chief's cars, 1 fuel wagon, 1 automobile fire engine, 12 horses, 5,000 ft. of hose and 11 alarm boxes. All possible speed has been made on the White Rock dam and reservoir.

Fortunately for Dallas the drought now seems to have been broken. Since July 1, 3.76 ins. of rain have fallen. On July 7 there was a cloudburst with 2½ ins. of rainfall. A freshet resulted and Elm Fork rose to a depth of over 8 ft., overtopped the temporary dams, and practically destroyed them. However, the Record's Crossing Reservoir was filled to overflowing and the city's pumps succeeded in snatching 30,000,000 gals. per day from the flood waters while the flow continued. For the first time in many months a pressure of from 40 to 42 lbs. was placed on the house services and the people allowed their fill of muddy water.

By July 19, with the pumps at Record's Crossing and Bachman's Reservoirs working 24 hrs. a day, 515,000,000 gals. had been stored in the three reservoirs. The White Rock dam was so far completed as to hold 400,000,000 gals. The pumping station here is still to be installed, which will force this water into the city's distribution system. The new concrete dam on Elm Fork is well under way and will impound 225,000,000 gals. additional. More wells are being sunk, and it is the policy of the city authorities to keep these auxiliary supplies intact, and to continue to pump from them, except when surface waters are running to waste. The Board of Commissioners are preparing plans for a water supply for a city of 250,000 population.

At the time these July rains came, the conditions were critical to the extreme. The Bachman's Reservoir was empty, and but 33 ins. of water remained over the suction inlet of the Turtle Creek pumping station.

The city of Dallas has just escaped a well-nigh total exhaustion of its water supply. At present the conditions are again normal, and there seems fair prospect that the city will be enabled to get through the period until the new works are completed and in operation without further serious stringency. The severe experience is one not likely to be forgotten. It is to be hoped that other cities will find a lesson in it, and that prevention of water waste and foresight for future needs will be more keenly felt, not only by municipal officers but by the people themselves.

It would be interesting to know the exact cost to Dallas of all the emergency measures, so hurriedly executed, which yielded so insignificant and precarious a supply. But this cost is insignificant compared with the discomfort and danger of those long eight months, when the city was continually menaced by danger of conflagration.

Brick Paving for Roads in Illinois and Ohio.

Brick paving for country roads has been used experimentally and on a small scale in Illinois for several years, and some new work of this kind has been undertaken recently. One piece of work consists of four miles of a road leading north from Newman, Ill., through a very flat and fertile farming country, in heavy black soil. The road carries a considerable traffic between farms and the town, but it was simply of earth construction and in wet weather became almost impassable for loaded wagons. An improvement was decided upon in order to

Fig. 1. A 9-ft. Brick Paved Strip in a 21-ft. Earth Road Near Newman, Ill.

remedy these conditions, and brick paving was adopted as being more durable and more economical (for a term of years) than any other material under the particular conditions.

The specifications provided for the improvement of 21 ft. of roadway, a width of 9 ft. at one side being paved with brick and the remaining 12 ft. being left as on earth road for travel during good weather. There is a 4-in. concrete base covered with a 2-in. cushion layer of sand, upon which is laid the course of vitrified paving brick. The joints are grouted with cement filler. On each side of the brick roadway is a concrete curb 4 × 12 ins.; this has its top flush with the paving and serves to hold the brick in place. In preparing the black soil as a foundation for the concrete, the grade of the road (for its full width) was elevated sufficiently to give drainage to both sides. Then the excavation was made for the concrete base, and its surface was thoroughly rolled with a heavy steam roller before the concrete was placed. A view of this road is shown in Fig. 1, in which the automobile is standing on the earth portion.

The cost was $32,000, or about $8,000 per mile. This was paid out of a fund created by levying an assessment of $1 on each $100 of assessed valuation in the township. The work was done by direction of the Township Commissioners, acting under the Hard Road act. Mr. Wm. E. Price, of Tuscola, Ill., was the engineer in charge of construction; the contractor was Mr. J. W. Roller, of Newman, Ill. As an example of the commercial value of this road it is stated that a two-horse team hauled five loaded farm wagons on the paved roadway when it was almost impossible to pull a single empty wagon on the wet and muddy earth road. The combined load was about 319 bushels of corn, or over 11 tons.

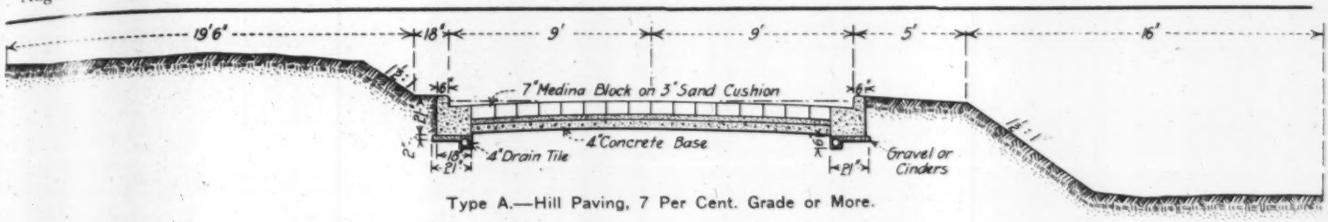
At Hoopeston, Ill., there is a similar roadway, but with brick paving 18 ft. wide, for a distance of 3,925 ft. on a road running north from the town. It is thought, however, that a width of 14 ft. would have been ample for the traffic. This also was done by the Township Commissioners, under the provision of the act mentioned above. The cost was about $13,770. As no bond was issued bearing interest for the payment of this work, non-interest bearing certificates were issued by the commissioners, and about 15% of the cost was charged by the contractor for interest on time payment.

It is considered by the Illinois Highway Commission that brick paving may be found desirable where the traffic consists largely of very heavy loads, and where it consists largely of automobiles. One stretch of macadam road (with bituminous binder) built near East St. Louis by the Commission has demonstrated clearly that it is not strong enough to carry the extremely heavy traffic, which consists largely of retail coal hauling. In this case, the loads are said to be quite beyond the strength of any limestone macadam, but it is considered that under average conditions a well-built bituminous macadam paving will prove adequate, and that this is much more comfortable for driving than a brick pavement. Where the traffic is heavy and a majority of the vehicles are automobiles, it is believed that there is nothing better than brick, especially as it requires no continual surfacing and maintenance. This latter traffic condition does not exist in many places at present, but an investigation is being made as to one such road near Chicago. As this road is used almost exclusively by pleasure traffic the owners of horses may object to brick, and it does not appear practicable to provide both brick and macadam of sufficient width for each class of the traffic. For this reason the investigation is being made and will include a census of the traffic.

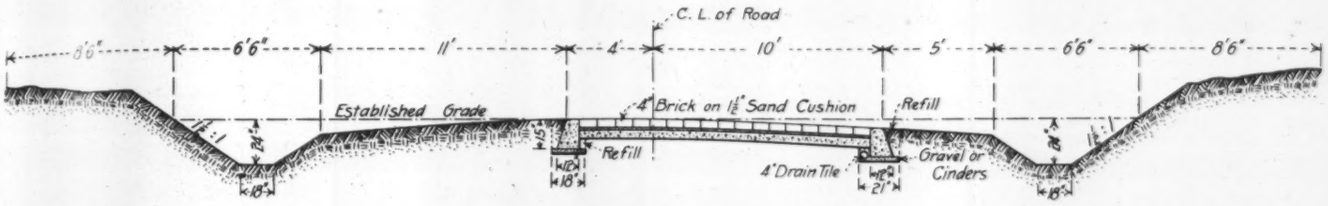
The use of brick paving for country roads has been tried in other parts of the country, and in some cases considerable stretches of road have been paved in this way. Probably one of the most extensive improvements of this kind is around Cleveland, O., where a number of country roads radiating from the city have been paved entirely with brick. In Cuyahoga County (in which Cleveland is situated) there are nearly 150 miles of brick-paved country road, and additional work of this kind is being built under the direction of the County Engineer. This was noted in our issue of Jan. 13, 1910, in connection with a hollow clay curb used on some of this county work. The general type of construction is shown in Fig. 2, and the following information concerning it is taken from the report for 1909 of the county engineer (then Mr. A. B. Lea):

The soil of Cuyahoga County roads, with few exceptions, is clay. On unimproved roads the nature of the soil is practically prohibitive of profitable or satisfactory travel for six months of the year. Except for the plank roads, of which there were only 40 miles, and a few miles of sandy loam base, the county was practically cut off from Cleveland in the wet months, before the improvement of the roads. It becomes necessary to maintain the roads in the rural districts in good condition every day of the year, else a hardship is put upon gardeners and farmers and the cost of living for residents of the city is increased. For these reasons the county commissioners early considered the manner of providing as much surface for travel as possible, of the most permanent construction for economical cost.

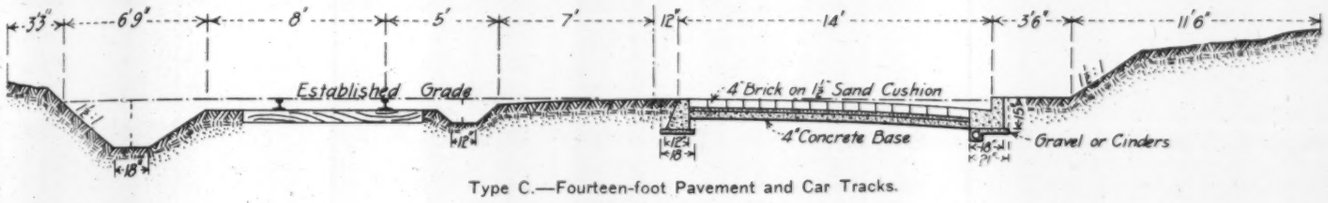
At first the county attempted to macadamize some of the roads. This process consisted of rolling a clay foundation, placing upon it a 6-in. layer of 2½-in. stone,



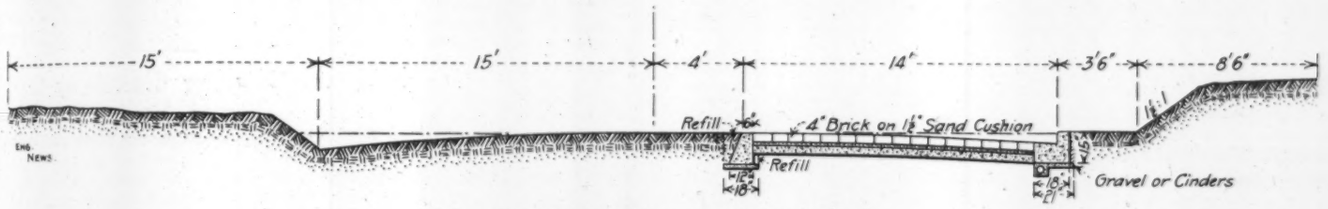
Type A.—Hill Paving, 7 Per Cent. Grade or More.



Type B.—Fourteen-foot Pavement With Side Ditches.



Type C.—Fourteen-foot Pavement and Car Tracks.



Type D.—Fourteen-foot Pavement With High Curb.

FIG. 2. SECTIONS OF COUNTRY ROADS WITH BRICK PAVING IN CUYAHOGA COUNTY, OHIO.

upon that a 4-in. layer of smaller stone, and then stone screenings to fill the voids. Each layer was rolled. These roads were utter failures because they were not constructed of good material and no heed was given to maintenance or drainage.

Thirteen years ago the commissioners determined to experiment with vitrified brick. South Woodland road and Wooster pike were built. These pavements were constructed of a width of only 8 ft. The material was not up to the standard of to-day. With lack of inspection and drainage the roads were not the success expected. They have been repaired the last year, and are now in good condition and will last until the needs of the communities justify wider pavements.

The commissioners again tried macadam, but the clay soil, carried by the wheels of wagons, gathered up the surface of the macadam roads. That and the automobile travel soon destroyed the roads. About six years ago the commissioners tried bitulithic, a mixture of tar and stone, on sections of Kinsman and State roads. These pavements have greatly deteriorated, probably by lack of proper drainage and of sufficient base to sustain the surface in proper form.

Now the county is building 165 miles of pavement, nearly all of which is to be 4-in. vitrified brick on a concrete base. This is considered the best pavement that can be obtained for the county.

It is the duty of the county engineer to carry out each contract for road or bridge work. He is responsible for the inspection of all material and the supervision of labor. He employs all necessary engineers, draftsmen and inspectors. Bids for the construction of roads are based upon the engineer's estimates of the amount of work to be done and quantities of materials to be used. The bids are by units on all items, instead of a lump sum for an entire contract.

The improvement is usually to a width of 30 ft. between ditches. The first curb is usually 4 or 5 ft. from one ditch. A pavement 14 ft. wide is built, leaving 11 or 12 ft. of earth road between an inner curb and the second ditch. This dirt road is graded. It is much used by farmers in dry weather, as they dislike to drive their horses on hard pavements continually. The dirt road, as a rule, is in excellent condition, for it is rarely used except in good weather.

Three types of curb are used. The concrete curb is 6 ins. wide at the top, 12 ins. at the base, and 15-in. deep. The sandstone curb is of two sizes; when used for the curb nearest the ditch it is 4 ins. wide at the top and 15 ins. deep; when used for the curb at the inner edge of the pavement, over which traffic drives, the top is 5 ins. wide.

The third type is vitrified block and the dimensions are 4 × 7 × 15 ins. for the outer curb and 5 × 7 × 15 ins. for the inner. Embraced in the vitrified curb is a core, or hollow, which serves as a French drain. This reduces the cost of construction, by making it unnecessary to lay a 4-in drain tile under the curb.

The concrete curb is composed usually of sand, cement, and stone or gravel. Blast furnace slag may be substituted for the stone or gravel. The engineering department has used this slag with much success. By reason of the lightness and strength of the material it makes a hard, substantial job. In rural work it is especially economical in view of its lightness, as a great factor in the cost is the weight of material to be hauled. When pavements built of slag more than three years ago, are taken up for the laying of water or gas pipes, the macadam base is found cemented together, indicating it to be a substantial material for macadam roads.

A combined earth and brick paved road in Ohio, described in our issue of Sept. 25, 1902, had a roadbed 26 ft. 6 ins. wide between ditches. A strip 14 ft. wide was excavated for a foundation of broken sewer pipe (2½-in. size); at each side of this was a trench 3 ft. deep from top of road, and with a 4-in. tile drain laid on the 24-in. bottom. The trenches were widened at the top to receive curbs of hollow tile blocks 18 ins. deep, the 6-in. top of the curb being level with the road surface. Between the curbs was a 10-ft. pavement of brick on a 1-in. sand cushion. Outside of each curb the broken tile was filled in to a width of 2 ft. This paved roadway left a berm of 3 ft. on one side and a 9-ft. earth roadway on the other side. About 60 miles of brick paving are now proposed for roads in Columbiana County, Ohio.

Concrete has been used in a similar way for the paving of country roads, but to a much smaller extent than brick. In Coshocton County, Ohio, one road has been paved with concrete for a width of 18 ft. (the full width), while another has a 10-ft. strip adjacent to a limestone macadam which had become worn under the heavy traffic. The concrete is 6 ins. thick, with a 5-in. base made of a 1:2:4 mixture (using river gravel), and a 1-in. wearing surface of 1:2 cement mortar. The contractors for both pieces of work were George J. Bock & Son, of Coshocton, O.

Concrete paving for roads has been used also on roads leading into Detroit, Mich., this work having been done under the direction of the Road Commissioners of Wayne County. According to a description in the "Proceedings" of the Illinois Society of Engineers and Surveyors for 1910, the paving is 10 ft. wide (in a road 24 ft. wide), with a fall of 2 ins. in 4½ ft. on each side of the center line, and then a corner radius of 6 ins. It has a 6½-in. bed of 1:2:4 concrete and each side is carried 4 ins. below the base for a width of 8 ins. Transverse joints are formed at intervals of 25 ft., using thicknesses of heavy building paper or a ½-in. pine board. The joints were filled with composition.

Taxation of Franchises.—The Supreme Court of California has decided, in the case of the County of Los Angeles vs. The Western Union and Postal Telegraph companies, that a county has a right to tax a franchise given by the state. It appears that a tax assessment was levied by the county assessor for $50,000 on a franchise allowing the companies to use the highways. The companies failed to pay the assessment when due and the county sought to collect. Then the Western Union Co., brought action to prevent the sale of its property. The Superior Court sustained the company but the county appealed to the Supreme Court which reversed the lower court. The basis of the decision seems to lie in the words:

> The claim that * * * taxation of this franchise is in any way taxation of its federal franchise is utterly without basis. The tax is solely on valuable property within this state—the right to the permanent and exclusive use of portions of the public streets of Los Angeles, free of compensation—a tax differing in no material way from one levied on its poles and wires located within said city.

Data From the Electric Operations of the West Jersey and Seashore R. R.

In a paper at the recent annual convention of the American Institute of Electrical Engineers in Chicago, June 28, 1911, Mr. B. F. Wood, Assistant Engineer, Motive Power Department, Pennsylvania R. R., Altoona, Pa., presented data of the operation of the West Jersey & Seashore R. R. (connecting Camden, Newfield, Millville and Atlantic City) under electric traction, supplementing earlier data given by Mr. Geo. Gibbs. (Eng. News, March 31, 1910.)

The data given by Mr. Wood are very complete and show in detail the distribution of expense items, etc. The accompanying tables have been arranged from the paper to show the most important and interesting information presented.

The transmission line noted in Table I is a 33,000-volt, three-phase type in duplicate. All the cars (79 coaches, 2 passenger-baggage, 6 baggage-mail and 6 baggage cars) are motor cars. There are no trailers or locomotives. The coaches weigh 1,630 lbs. per passenger, and new steel-car equipment has been ordered weighing only 1,445 lbs. per passenger. Each one carries two 200-H.P., 675-volt, direct-current motors with multiple-unit control.

The headings of Table II are self-explanatory with the exception of "other expenses," which include the cost of maintenance of way and structures, despatching trains, gatemen, traffic and general expenses. The average monthly cost per car mile is seen to be slightly lower in 1910 than 1909 and to be the lowest, 12.04 cts., at the time of heavy seashore traffic in 1910.

Table III shows general power data, by months, for the years 1907-1910. A progressive gain is seen in the reduction of power cost and coal consumption per kilowatt-hour. The greatest improvement has been in efficiency of transmission and conversion, secured by careful operation of substations.

In Table IV it is seen that the greatest number of actual detentions, and the minimum average number of car miles per minute of detention is due to the transportation itself and not to the equipment. The figures in Mr. Wood's paper on failures of train equipment show the greater number to be in fuses blown, defective control, armature troubles and hot bearings. In 1910 failures from broken pinions of motor gearing were eliminated.

TABLE I—GENERAL DATA; W. J. & S. R. R.

Miles route	80.6
Total miles single track	150.0
Total miles transmission line	69.3
Number of substations	8.
HP. capacity in substations	17,000.
HP. capacity of power-house	8,000.
Number of motor cars	93.
Construction Costs:	
Power station	$994,900
Power station, per KW	124
Transmission line	241,500
Transmission line, per mile	3,485
Substations	491,560
Substations, per KW	29
Third rail	557,636
Third rail, per mile	4,235
Overhead trolley wire	80,500
Overhead trolley wire, per mile	4,120
Track bonding, reconstruction, right-of-way, etc.	3,617,959
Terminals, sheds, etc.	299,074
Cars	1,135,900
Signals, telegraph, telephone, interlocking	667,000
Miscellaneous	44,200
Total cost	8,130,229

TABLE III.—GENERAL POWER DATA: ELECTRIC TRAIN SERVICE; W. J. & S. R. R.

	A. C. KW.-hr. power sta. output.	Output cost, mills per KW.-hr.	Lbs. of coal per KW.-hr.	Eff'y. power sta. bus to substa. bus.
1907.				
January	1,911,600	8.83	3.91	72.6
February	1,691,500	7.95	3.63	74.5
March	1,583,000	7.76	3.96	71.5
April	1,464,300	7.43	3.95	74.0
May	1,400,400	6.81	3.53	72.1
June	1,395,700	7.65	3.98	70.6
July	1,938,100	6.05	3.65	71.6
August	2,082,000	6.00	3.43	71.6
September	1,855,300	6.07	3.46	71.7
October	1,849,800	5.99	3.53	52.8
November	1,893,600	5.86	3.51	71.3
December	2,053,600	6.00	3.51	72.5
Av. for year.	1,759,900	6.80	3.67	72.2
1908.				
January	2,009,600	6.10	3.49	73.3
February	1,913,100	6.35	3.55	73.6
March	1,873,300	6.17	3.46	72.3
April	1,836,200	5.86	3.45	71.8
May	1,744,900	6.06	3.40	69.6
June	1,707,500	5.91	3.52	74.8
July	2,104,300	5.43	3.37	75.6
August	2,268,000	5.43	3.18	75.8
September	1,849,200	5.76	3.18	74.7
October	1,786,700	5.78	3.25	72.8
November	1,802,000	5.78	3.35	74.7
December	1,993,000	5.80	3.25	76.2
Av. for year.	1,907,300	5.92	3.37	73.8
1909.				
January	7,959,700	5.67	3.23	76.1
February	1,756,500	5.71	3.25	76.1
March	1,903,600	6.04	3.33	76.1
April	1,869,300	5.90	3.27	75.0
May	1,788,800	5.65	3.26	75.5
June	1,749,200	5.77	3.22	77.7
July	2,426,000	5.21	3.25	78.0
August	2,324,400	5.27	3.34	81.5
September	2,056,100	5.28	3.34	80.3
October	1,836,600	5.40	3.27	80.1
November	1,869,500	5.49	3.41	80.7
December	2,154,800	5.42	3.41	81.0
Av. for year.	1,962,600	5.55	3.30	78.4
1910.				
January	2,131,000	5.15	3.31	81.8
February	1,865,300	5.73	3.46	82.4
March	2,168,600	5.42	3.27	81.3
April	2,031,400	5.62	3.22	80.1
May	2,115,900	5.25	3.27	79.5
June	2,157,500	5.68	3.14	80.3
July	2,784,300	5.88	3.16	82.5
August	3,088,300	5.11	3.06	80.7
September	2,590,400	5.17	3.31	82.9
October	2,229,000	5.48	3.17	80.8
November	2,381,500	5.19	3.29	81.9
December	2,759,300	5.31	3.39	83.4
Av. for year.	2,359,400	5.42	3.25	84.6

TABLE II.—COST OF PASSENGER TRAIN OPERATION IN CENTS PER CAR MILE: W. J. & S. R. R.

	Rep'rs, elec. equip. cars.	Repairs pass. cars.	Other maint. equip. costs.	Elec. power at car shoes.	Yard service shifting costs	Motormen.	Trainmen.	Train supplies and expenses.	Total.	Other expenses.	Total expenses.	Car miles, Total.	Av. cars per train.
Year 1909.													
Jan.	1.06	2.05	0.48	4.78	0.51	0.93	1.53	1.20	12.53	10.25	22.78	279,210	3.113
Feb.	1.07	2.42	0.38	4.63	0.51	0.91	1.49	1.22	12.63	10.99	23.62	258,130	3.163
March	1.18	1.97	0.35	4.99	0.52	0.99	1.65	1.18	12.83	10.17	23.00	279,193	3.092
April	1.26	2.03	0.25	4.43	0.46	0.89	1.40	0.61	11.32	9.14	20.46	317,963	3.483
May	0.84	1.73	0.26	3.98	0.44	0.88	1.45	0.45	10.03	9.18	19.21	318,006	3.482
June	0.40	0.68	0.31	3.58	0.25	0.86	1.41	0.42	7.91	9.35	17.26	339,294	3.530
July	0.33	0.44	0.12	2.82	0.20	0.80	1.25	0.40	6.36	6.95	13.31	478,203	3.669
Aug.	0.28	0.40	0.14	2.75	0.20	0.75	1.18	0.36	6.06	6.29	12.35	517,223	3.921
Sept.	0.43	0.67	0.14	2.75	0.25	0.83	1.32	0.42	6.81	6.87	13.68	428,571	3.584
Oct.	0.64	0.71	0.24	3.84	0.31	0.92	1.53	0.62	8.81	10.21	19.02	307,525	3.046
Nov.	0.52	0.39	0.29	3.85	0.29	0.95	1.70	0.82	8.81	9.30	18.15	291,816	3.327
Dec.	0.87	1.08	0.29	12.31	0.30	1.00	1.72	1.30	18.87	15.05	33.92	292,175	3.318
Average.	0.68	1.10	0.25	4.30	0.33	0.88	1.44	0.69	9.67	9.08	18.75	4,107,609	3.457
Year 1910.													
Jan.	0.86	1.03	0.67	4.59	0.46	0.96	1.64	2.24	12.45	7.22	19.67	292,523	3.169
Feb.	0.79	1.78	0.33	5.38	0.50	0.97	1.48	1.07	12.30	12.44	24.74	262,488	3.137
March	1.04	1.13	0.28	3.87	0.48	0.88	1.51	0.89	10.08	12.91	22.99	333,252	3.445
April	0.62	0.76	0.31	4.57	0.49	0.97	1.62	0.70	10.04	11.55	21.59	302,463	3.344
May	0.57	0.78	0.24	2.78	0.48	0.89	1.41	0.44	7.59	9.92	17.51	351,994	3.651
June	0.79	0.67	0.24	2.80	0.45	0.97	1.62	0.58	8.12	10.13	18.25	375,023	3.406
July	0.44	0.46	0.18	2.47	0.34	0.89	1.39	0.36	6.53	6.66	13.19	565,787	3.641
Aug.	0.29	0.57	0.15	2.48	0.33	0.85	1.38	0.37	6.42	5.62	12.04	594,852	3.811
Sept.	0.37	0.54	0.21	2.71	0.39	0.85	1.42	0.42	6.91	7.34	14.25	487,543	3.771
Oct.	0.73	1.19	0.28	3.05	0.47	0.91	1.69	0.52	8.84	12.34	21.18	339,789	3.564
Nov.	1.40	2.45	0.47	3.71	0.51	0.96	1.71	0.54	11.75	10.58	22.33	311,882	3.379
Dec.	0.63	1.94	0.21	3.93	0.51	0.93	1.71	0.74	10.60	12.13	22.73	334,936	3.494
Average.	0.66	1.01	0.27	3.33	0.43	0.91	1.52	0.67	8.80	9.39	18.19	4,552,532	3.518

TABLE IV.—DETENTIONS TO ELECTRIC TRAIN SERVICE, 1909; W. J. & S. R.

Causes.	Number.	Minutes total.	Car miles per minute detention.
Transportation.			
Boat connection	51	180	2,815.56
Baggage, express & mail	7,898	8,373	490.47
Heavy travel	1,232	4,612	890.45
Collecting tickets	72	334	2,295.70
Train connections	977	5,517	744.38
Traffic ahead	1,723	7,842	523.68
Held at signal	1,390	4,767	861.56
Stops on order	73	165	5,889.49
Fast schedule	34	57	2,048.50
Picking up and cutting off cars	411	1,312	3,130.15
Fog	41	127	2,336.73
Signal failure	208	860	4,775.31
Accidents	26	261	5,734.73
Obstructions	33	194	1,169.69
Miscellaneous	283	1,427	2,877.90
Total transportation	4,852	36,028	113.98
Motive power.			
Power-house trouble	15	69	59,518.39
High tens'n line trouble	14	81	50,700.80
Lightning	12	47	87,377.90
Overloads in substations	11	61	67,324.00
Third rail shorts	3	14	293,340.40
Third rail out of place	1	8	513,345.13
Third rail anchor on fire	1	5	821,353.00
Third rail protection out of place	1	1	4,106,765.00
Trolley wire trouble	253	1,920	2,138.94
Train equipment	237	1,568	2,619.11
Total motive power	548	3,774	1,088.17
Weather conditions.			
Snow, head winds, wet rail	178	4,043	1,015.77
Sleet on third rail	47	812	5,057.59
Total weather condition	225	4,855	845.88
Grand total	9,225	44,657	91.96
Total car mileage			4,106,765
Car-miles per detention			445.18
Car-miles per minute of detention			91.96

Mixing and Conveying Concrete by Compressed Air.

A machine for simultaneously mixing and conveying concrete by compressed air is one of the latest devices in concrete machinery, and it has been used already on important engineering work with successful results. The delivery of concrete by pressure through pipes has been tried before, but generally with poor results, although the forcing of cement-grout through small pipes has been used extensively and successfully in this country and abroad. The principle of operation in the present case is as follows: the measured materials for a batch are charged into a receiver or chamber, which is then closed; air pressure is turned on, forcing the material down a short vertical pipe at the bottom of which is an elbow connection to the horizontal delivery pipe. At the back of this elbow is an air pipe discharging directly into the delivery pipe.

A machine installed for the work at the LaSalle St. tunnel, Chicago, is shown in Fig. 1. The chamber (A) has a cylindrical body and conical base, and is supported by legs attached to an annular base plate; the capacity of the chamber is 6 cu. ft., but may be of any size up to about 24 cu. ft. This is filled from a hopper above it by means of a circular air-tight intake valve (B). The cement, stone and sand and finally the water, are placed in this hopper (which is above the platform at the top of the view), and are mixed to a certain extent by falling through the valve to the chamber. The outlet elbow (C) is 10 ins. diameter, with a reducer 10 to 6 ins. diameter, which has a flanged connection for the delivery pipe (D), through which the concrete is conveyed to the point of deposit. The chamber has two 1½-in. pipe connections for the admission of compressed air. The horizontal pipe (E) admits air to the top of the chamber, immediately below the inlet valve. From this pipe is a branch (F) terminating in a horizontal nozzle fitted to the back of the elbow casting. The air is admitted to both points simultaneously, by means of the valve (G). Should it be desirable for any reason to blow air into the pipe only, this can be done by the by-pass (H), the valve (G) then remaining closed.

The compressed air at 40 to 60 lbs. pressure forces the contents of the chamber down to the elbow (this movement taking only one or two seconds), where it is struck by the horizontal jet having a velocity of 1,000 to 2,000 ft. per

FIG. 1. PNEUMATIC APPARATUS FOR MIXING AND CONVEYING CONCRETE AT THE LA SALLE ST. TUNNEL WORKS, CHICAGO.
(J. H. MacMichael, Chicago, Inventor.)
(Drake Standard Machine Works, Chicago; Builders.)

sec. This gives to the mixture a velocity of 30 to 40 ft. per second, and causes a violent agitation, the mixing being done mainly in the first few feet of the delivery pipe. The current of air reduces the frictional resistances so that no difficulty is experienced in conveying the concrete for a considerable distance. It has been conveyed about 350 ft. horizontally (315 ft. in 10 secs.), and can be raised vertically to a height of about 100 ft., according to the pressure used. On work for the piers of the Harvard-Dennison viaduct in Cleveland, O., concrete was conveyed through an 8-in. pipe to a height of 80 ft. above the mixer, using air at 35 to 45 lbs. pressure. This work was done by the Concrete Steel Construction Co., of Pittsburg, Pa., in 1909. The movement is due not only to the impact of the air jet but also to the expansion of the air from receiving chamber to the end of the pipe.

It is stated that with 100 ft. of 6-in. delivery pipe, about 5 or 6 cu. ft. of free air are required for each cubic foot of concrete in the batch, and probably an additional 50% of the amount of air for each additional 100 ft. of pipe. The bends should have a radius of not less than 5 ft., so as to avoid clogging or excessive wear. It is found that the first discharge into a clean pipe gives a coat of ⅛-in. to ½-in. of mortar, which is displaced and replaced by the succeeding discharges. At the end of the day's work, the pipe line must be cleaned by discharging water through it. The rapidity of the work will depend upon the speed of preparing the batches and the capacity of the compressor. Much depends also upon the operator; if he leaves the air valve open too long, in order to be sure of getting a thorough discharge of the concrete, he may cause a considerable loss of air by blowing out through the empty pipe.

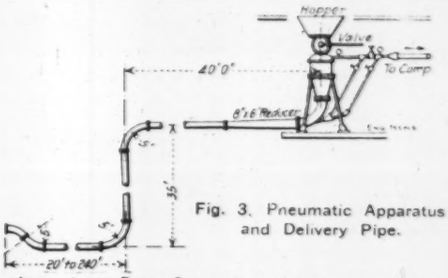


Fig. 3. Pneumatic Apparatus and Delivery Pipe.

An interesting application of this device is in delivering the concrete for the lining of the LaSalle St. tunnel under the Chicago River. This tunnel consists of a twin-tube steel shell, as described in our issues of Jan. 12 and April 13, 1911, and each shell has a concrete lining. Fig. 2 shows the general arrangement, and Fig. 3 shows the concreting plant. There was a maximum horizontal distance of 290 ft. from the receiver to the point of discharge, with a vertical drop of 35 ft. The machine had a capacity for batches of 6 to 7 cu. ft., and batches were delivered to a distance of 315 ft. in 10 seconds. It is stated that much of the work was done at the average rate of 48 batches per hour (say 10 cu. yds. per hour), delivered through 100 to 300 ft. of 6-in. pipe. For this work there were 8 men (1 machine operator, 5 wheelbarrow men, and 2 men in the tunnel to shift the form bulkheads and pipes. The labor cost (at 37½ cts. per hour) was $3 per hour, and at 8 cu. yds. per hour (allowing for unavoidable delays) the average cost of mixing and conveying concrete would be about 38 cts. per cu. yd. M. H. McGovern Co., of Chicago, has contract.

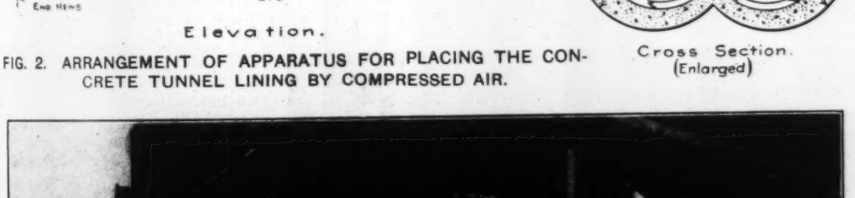


FIG. 2. ARRANGEMENT OF APPARATUS FOR PLACING THE CONCRETE TUNNEL LINING BY COMPRESSED AIR.

The same machine had been used previously in grouting the broken stone dumped inside the cofferdam at the connection with the north approach or shore tunnel. Before dumping the stone, vertical 2-in. grouting pipes about 4 ft. apart were secured in place, their lower ends extending to within 6 ins. of the bottom. A hose pipe was attached to each pipe in turn, and two 8-ft. layers of stone were grouted in this way. The grout was forced to a total depth of 52 ft. from the mixer and was discharged under water, the cofferdam not being pumped out. It also forced its way under the tubes to a horizontal distance of 27 ft. from the pipes. An experiment was made with grouting stone mixed with sand, but this proved unsucessful, as the sand could not be moved by the grout and therefore checked or clogged its flow. The air compressor used on this work had a capacity for compressing 275 cu. ft. of free air per minute to a pressure of 60 lbs. per sq. in. Fig. 4 is a view of this cofferdam work, with the grouting hose attached to one of the vertical pipes (A). About 80 sacks of 1:1 cement grout were delivered through 165 ft. of 2-in. pipe in an hour. The cofferdam is of steel sheet piling, and the stone filling closes the spaces between the piling and the tunnel tubes. The grouted stone and the steel sheeting both proved tight when cofferdam was pumped out, although depth is 45 ft.

The process has been invented and patented by Mr. J. H. MacMichael, and the apparatus is built by the Drake Standard Machine Works, 1025 Jackson Boulevard, Chicago.

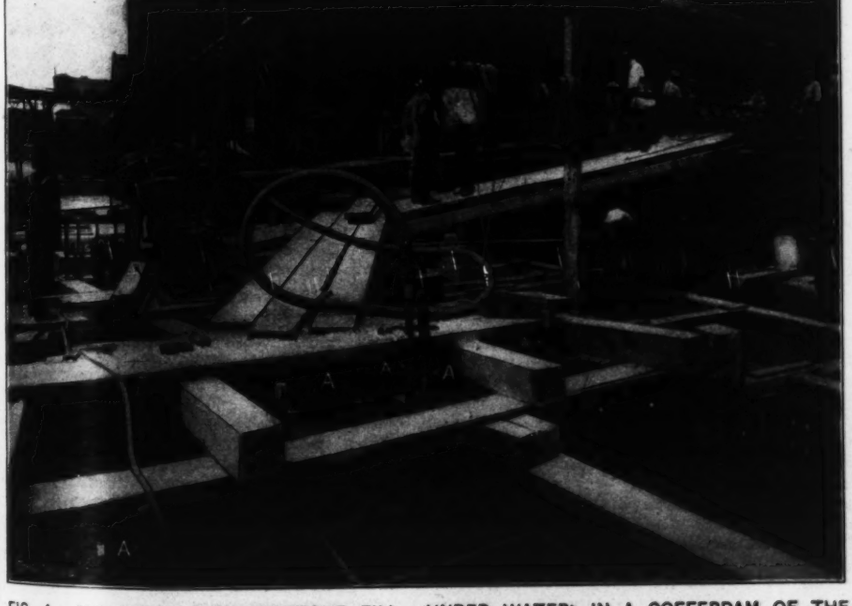


FIG. 4. GROUTING A BROKEN-STONE FILL (UNDER WATER) IN A COFFERDAM OF THE LA SALLE ST. TUNNEL, CHICAGO, BY MEANS OF THE COMPRESSED AIR APPARATUS.

Schemes of Erection Proposed for the Quebec Bridge.

The design of a structure of exceptional size is likely to depend more upon erection questions than on problems of proportioning the parts with regard to their functions in the completed structure. This is preeminently true for a bridge like that to be built over the St. Lawrence River at Quebec. Accordingly, the recent competition of designs and bids, of which we showed the principal designs some time ago [in our issue of April 20, 1911], was in part a competition of erection methods. The outlines of the designs do not therefore suffice to state the essentials of the competing plans. We take pleasure in supplementing them now by a summary of the erection projects of the more important bids.

The plans prepared by the Board of Engineers allowed of six modifications of its general design, the differences being in the length of anchor arm, design of suspended span, and manner of erection. Alternative designs were also permitted. There were four bidders [see Eng. News, April 20, 1911], and, some of them submitting proposals for different schemes of erection, there were 35 distinct bids.

Maschinenfabrik Augsburg-Nuernberg A. G.; Board's Design.

In two forms of the Board's design, the entire bridge is to be erected by cantilevering. Erection would start from the main piers, both the anchor and the cantilever arms being erected without falsework. To insure stability the anchor arm is temporarily supported at panel-point AL10 by a steel temporary bent resting on concrete footings.

Before erecting the permanent truss members, a temporary framework spanning from the main pier to the temporary bent is erected by derricks (see Fig. 1). The floor members of the bridge being erected on this framework, the erecting cranes would be built on this floor.

It is proposed to erect the bridge by double-jib traveling cranes, two on each arm, having cross travel on a tower or trestle arranged to run longitudinally along the floor of the bridge. All movements are to be by electric power. Each crane has a lifting capacity of 200,000 lbs. Erection can therefore proceed simultaneously at four different points. The rails on which the crane trestles are to run are to be laid on the regular stringers, which for this service could be shifted towards the main trusses of the bridge. The expense of providing four cranes on each side of the river was considered warranted on account of the amount of time saved for the completion of the work. Erection is to proceed on both sides of the river at the same time.

The cantilever-arm traveling crane will be built first and the work of erection will commence at panel A13 to C13 (panel-point 14 is the main post), including the erection of the temporary supporting bent and its adjoining members. While this work is progressing the anchor-arm crane will be erected in panel A11 — A10 and work started on the erection of the first anchor-arm triangle L14 — U12 — L10. The diagonal members AU12 — AL14 are temporarily strengthened, because they become compression members for a time. An auxiliary member is to be inserted between the points AM13 — CM13 to serve for regulating the system during the first cantilevering out.

While the bridge construction below the floor is being cantilevered out panel by panel, assisted by auxiliary members, some of which are adjustable, the posts and upper-chord members between the two compression diagonals are put in place, by means of the crane operating from central position.

When cantilevering out the cantilever-arm, the intermediate chord points M3 and M1, as well as the upper chord points U2 and U0, are connected to the floorbeams of the bridge by special stiffeners in order to increase the lateral rigidity of the trusses.

CANTILEVER ERECTION OF SUSPENDED SPAN.—In cantilevering out the suspended span, the first two panels are erected in the same manner as the last panels of the cantilever arm by using the same traveling cranes. By lowering the working platforms both the traveling cranes are then changed into upper chord cranes, thus decreasing the weight and consequently the stress in the members of the bridge. These upper chord cranes then work in the usual manner, panel by panel, up to the center of the bridge.

The operation of connecting up at the center of the suspended span is facilitated by means of strong adjusting devices connected with the top and bottom chords at the end of the cantilever arms.

SUSPENDED SPAN FLOATED IN.—This scheme necessitates the erection of the suspended span on high steel falsework, this falsework being supported in turn on large pontoons, the whole being finally towed into position. The height of the falsework is such that at low tide the suspended span is about 2 ft. higher than corresponding points on the cantilever arms. The hanger or rocker U0 — L0 is composed of wire cables, and thus is enabled to buckle under compression. On this account the connection between the suspended span and the cantilever arm (by means of the pin at L0) can be made at any time and the suspended span still remain on the falsework and move up and down with the tide. The connection need not be made simultaneously at all four corners as would be the case if these members were composed of rigid eyebars.

The steel falsework is first erected on concrete pedestals, situated in some bay or cove adjacent to the bridge site. When the span has been completely erected over the falsework, scows are floated under the falsework between the piers, and the structure transferred to the scows by first partially filling the scows with water and, when they are in place under the bearings provided, pumping the water out. Four scows each 275 ft. × 46 ft. are proposed for this operation.

When the suspended span has been towed to the site and placed in position, water is again let into the scows and the entire scaffolding is lowered to such an extent as to enable its being freely floated out from under the bridge.

Maschinenfabrik Augsburg-Nuernberg; Bidder's Design.

The design proposed has a single-intersection web-system, similar to the Board's design, but the web triangles are considerably larger. The lengths of the several arms of the bridge are somewhat different, but the main span is unchanged. The design was made with the intention of floating in the suspended span.

On account of the long panels the floorbeams are very heavy. To facilitate manufacture and erection they are built as box-girders, the two webs being shipped separately and connected after erection by a cover plate. In order to limit as much as possible the use of secondary members and also to facilitate certain parts of the erection, eyebars are used to only small extent in the design. The top chords and main tension members are built-up riveted members. Each main pier is provided with a special pedestal of cast steel providing a central transmission of load on the pier and permitting of free deflection of the bridge. The pedestals are set on riveted steel grillages sunk into the masonry piers to provide a uniform distribution of load. The center span is suspended from the cantilever arms by means of cables, just as proposed for the Board's design.

Fig. 2 shows several stages in the erection, and illustrates the general method proposed. Both arms are to be cantilevered out from the main piers and the stability of the work ensured by temporary supports under the anchor arm. In this case, however, traveling cranes are operated on the top chords, two on each anchor arm and two on each cantilever arm at the same time. These cranes have 82-ft. booms and are arranged so as to be able to be moved crosswise on a crane trestle which itself can move longitudinally on the upper chords of the bridge. All cranes as well as the crane trestles are operated by means of electrically-driven winches. Each of the cranes has a maximum lifting capacity of 120,000 lbs. at the extreme end of its boom and a capacity of 200,000 lbs. within a closer area.

The erection of the main bridge parts with the laying down of the shoes. The shoes are designed to be floated in place and be set on previously prepared bearings as the tide goes down. While the shoe is being put in place, the temporary falsework at points 6 and 7 is raised and posts 6, 7 and 8 erected along with the sway bracing of the bridge. The crane trestle for the anchor arm and its two traveling cranes are placed on top of the group of posts 6, 7 and 8, which with its permanent and temporary bracing acts as a tower. After the cranes have erected the missing parts of the main trusses and the flooring between 6, 7 and 8, the crane trestle is brought to its second position on the posts 6 and 7 in order to make way for the cantilever-arm crane trestle and cranes. These cranes then build panel by panel the main trusses, bracing and floor of the bridge up to the anchor pier on one side and the end of the cantilever arm on the other, employing during the operation such temporary members as are required.

All material for erection is lifted on to the bridge from scows. The hoisting is done by a crane traveling on the floor of the bridge, having a capacity of 200,000 lbs. This crane can then transport the material to any point on the bridge where it is required. The runway tracks of this crane always project beyond the last panel erected in order to serve the overhead cranes to the best advantage.

The suspended span would be erected on high falsework as for the Board's design. The span is supported at each panel-point, by a truss on the falsework, the whole carried on four pontoons each 295 ft. long and 49 ft. 3 ins. wide. When the suspended span has been completely erected on the floating scaffolding, it is towed to the bridge site. After its arrival there it is accurately held in position by means of wire cables and winches placed on the banks of the river.

To facilitate the operation of coupling up the suspended span to the cantilever, as well as to avoid blocking traffic on the river any longer than absolutely necessary, a special supporting and lifting device is provided at the ends of the cantilever arm. This temporary support is made of cross beams suspended from the end posts of the cantilever arms by means of hinged tension members. At high tide these supports, previously swung back in a slanting position towards the piers to allow the suspended span to be floated into its closely approximate final position, are allowed to swing back to their normal position, the cross beams passing under the ends of the bottom chord of the suspended span at its four corners. As the tide goes out the bridge comes to rest on these temporary supports and the falsework floats clear. The suspended span is then adjusted to its final position by means of 16 hydraulic jacks located on the upper chord, each having a capacity of 1,322,000 lbs. and a lift of about 3 ft., operating a frame connected to the above mentioned cross beams. A safety device holds the cross beams in place step by step as it is raised, thus providing against any accident. When the lifting has been completed the wire hangers are fitted to their bearings and the suspended span, previously lifted a little too high, is lowered to its permanent position.

British Empire Bridge Company, Ltd.

The British Empire Bridge Company tendered only on the Board's design, but proposed three different schemes of erection of the suspended span: (a) cantilevering out; (b) floating in on high falsework; and (c) floating in a special truss to be used as stage or falsework upon which the suspended span proper will be afterwards erected.

The method of erection of the cantilever and anchor arms is naturally the same for all three cases (Fig. 3). The work is started by first building a high steel tower, two legs of which will rest on the main pier, while the other two are on special concrete pedestals. These towers will be slightly higher than the top chords of the bridge. On top of the tower will be erected

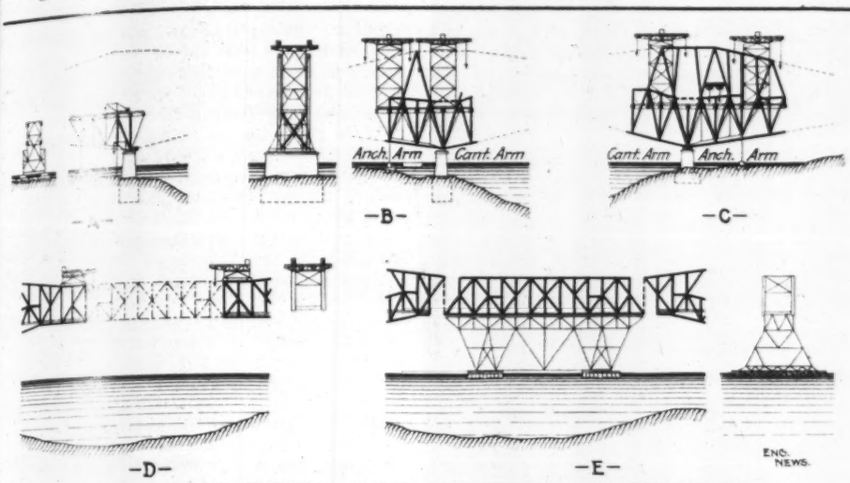


FIG. 1. MASCHINENFABRIK AUGSBURG-NUERNBERG, BOARD'S DESIGN.

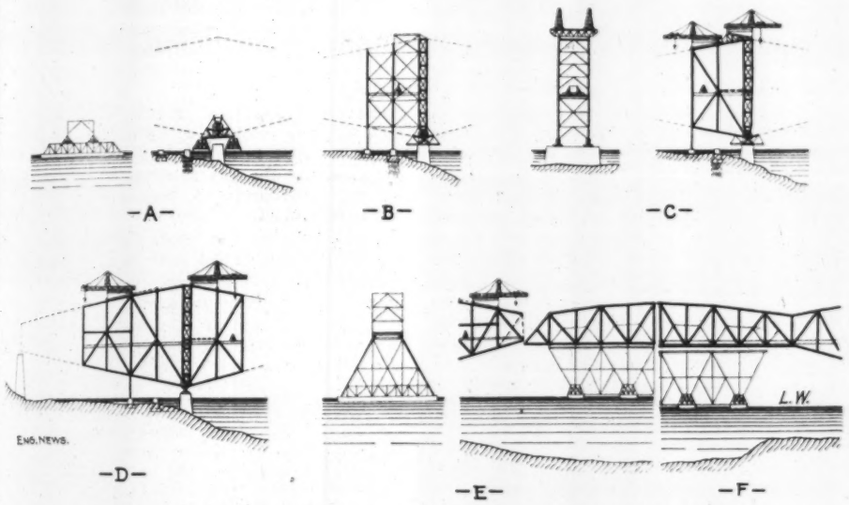


FIG. 2. MASCHINENFABRIK AUGSBURG-NUERNBERG, BIDDER'S DESIGN.

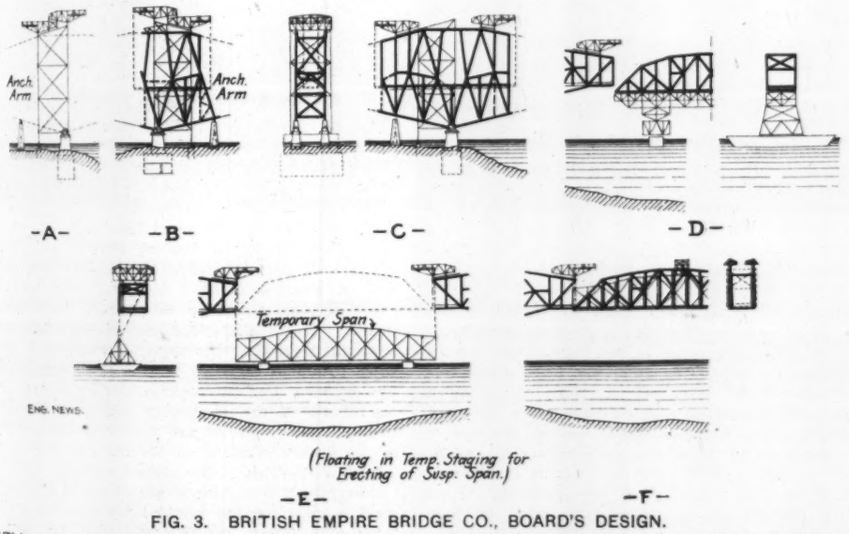


FIG. 3. BRITISH EMPIRE BRIDGE CO., BOARD'S DESIGN.

(This proposal includes a scheme for erecting the suspended span on a temporary span floated in.)

the two travelers to be used for the erection of the bridge itself, one to be used on the top chord of the anchor arm and the other on the top chord of the cantilever arm.

A portion of the material is to be delivered by water and a portion by rail. The material delivered by water will be erected by the travelers standing on the top of the tower and the erection will be carried forward by water as far as convenient. Afterwards the material will be delivered by rail. For this purpose a trestle will be erected between the land and the portion of the steelwork already erected.

To obtain stability during erection a temporary concrete pier will be built under panel point AL10. This pier will have eyebars built into it, to which the truss may be anchored. During erection the member AU12—AL10 will be reinforced so as to act as a compression member. After the travelers have done all the erecting possible from their position on the towers, they are transferred to special tracks on the top chords from which position they proceed with the erection, panel by panel. As both the cantilever and anchor arms are erected as cantilevers the stresses during erection are the same as in the completed bridge, and all joints will be riveted up complete as the erection proceeds.

SUSPENDED SPAN CANTILEVERED.—When the cantilever arms are completed the same top-chord travelers can proceed with the erection of the suspended span to junction at the center. The adjustment at this point is controlled by adjustable members between the suspended span and cantilever arm.

SUSPENDED SPAN FLOATED IN.—Floating the suspended span into place permits of work on this part of the structure to be pushed ahead at the same time as the other parts of the bridge. In the case of the high floating erection, the falsework is to be erected on concrete piers at Sillery, about three miles below the bridge site. The falsework consists of a long truss supported on two towers, the foot of each tower being carried on a pontoon 225 ft. long, 45 ft. wide and 30 ft. deep. The panel-points of the supporting falsework correspond to the panel-points of the suspended span, permitting the use of eyebars in the bottom chord of this span. The falsework is not transferred to the pontoons until the suspended span has been completed and everything is ready for towing to the site. It is built high enough so that at extreme low tide there is no chance of the suspended span putting any load on the supporting cables attached to the cantilever arm, during the operation of coupling up. The falsework is securely attached to the pontoons, but the span itself is supported on special bearings, preventing any side or lateral movement but leaving the falsework free to descend below the span when required. This prevents any chance of the weight of the falsework and pontoons being taken on the structure. The pontoons are fitted with pumps and valves so that the level of the steelwork can be controlled at all times. The pontoons are held in position under the bridge by the tugs supplemented by anchors and moorings attached to winches on the adjacent shores. Navigation on the river would have to be stopped during the operation of floating in.

STAGE ERECTION.—The third scheme for erecting the suspended span proposed by this company is by means of a special temporary span which is floated in and suspended between the two arms of the cantilever arms, and upon which the permanent span is finally erected.

In general this supporting stage consists of two main trusses spaced 64 ft. c. to c., each main truss being made up of two independent trusses spaced 9 ft. c. to c., the two being securely braced together so that they would act as a single truss. The construction of the stage is made as light as possible, wire cables being used for all tension members, the compression members being of nickel-steel. The weight of each double truss is about 510 tons. The spacing of the vertical posts and diagonal bracing is arranged so as to give free access to joints and connections of the permanent span to facilitate driving of pins, riveting, etc., and the top and bottom chord are either above or below the corresponding chords of the suspended span. The floor of the stage is as shallow as possible, so as not to interfere with the clear headway required for navigation. The floorbeams are attached to the side trusses by a knuckle bearing between the trusses, thus ensuring equal distribution of load.

In erecting the stage it is intended that each double truss will be hoisted in place separately by means of the top-chord travelers and slung from the end of the cantilever arms. To ensure stability during hoisting and until the floor system and bracing was put in place the particular form of truss used was decided upon. Until the wind bracing is put in, the trusses are guyed to the ends of the travelers overhanging from the end of the cantilever arms.

The suspended span will be built on the stage floor outside the temporary girders. When this truss is completed it will be hung in its proper place, being attached, however, to the temporary truss to prevent lateral motion or stress from wind. The floor and bracing will then be put in place, the dead load of which will be car-

ried by the permanent structure, the temporary staging being required to carry only the dead load of two main trusses. Special adjusting devices are placed under the panel points of the suspended-span trusses during construction, to correct whatever deflection may take place in the temporary staging under the constantly increased load.

Pennsylvania Steel Company.

The Pennsylvania Steel Co. proposed three different schemes of erection on the Board's design in addition to submitting a tender for a suspension bridge based on a design by Mr. Gustav Lindenthal. The different schemes of erection of the cantilever designs differ only in the manner of the erection of the suspended span, viz., by cantilevering out, by floating on high falsework, and by floating on low falsework and hoisting into place. The method of erecting the cantilever and anchor arms is naturally the same in all cases.

Preparatory work in the nature of storage yards, crane, runways, loading and unloading gantrys, etc., is fully provided for by the proposal, and some of it is shown in the first of the sketches in Fig. 4. At the north side, where erection would start, there is a heavy timber elevator to deliver the bridge material from the upper to the lower level, as the company proposes to bring all material in by rail. On the lower level a yard served by a 100-ton gantry is laid out for storing and handling material to be used on the north side. The material for the south half of the bridge will be brought to the north side and carried by the north gantry crane, assisted by a special derrick car, to a barge slip, whence the steel is transferred across the river on barges. On the south shore it is received by a gantry equipment similar to that on the north shore. All machinery is operated by electric power. An electric winch helps handle the scows and a motor operates the material trucks on the tracks from the gantry yard to the slip.

The first step in the erection will be the raising of a steel tower, 46 × 50 ft. and 248½ ft. high, behind the main pier. This tower will be equipped with four booms of 90 tons capacity operating from the corners at the top. The booms are fed either directly from the gantry yard or by a special track leading from the yard.

The derricks on the tower erect the falsework between the pier and AL10, after which the permanent bridge steel, including the shoe, bottom chords, laterals, etc., up to the bridge floor is put in place. With a suitable number of additional stringers placed on the floor, the upper part of the tower is disconnected from the lower part at the level of the floor. The top is then skidded along the bridge floor until it is in a position directly over the main pier. The lower part of the tower is then taken down and re-erected on top of the section already in place. On the top of this reconstructed tower the booms are again erected, the hoisting engines remaining on a platform on the tower at the floor level.

The tower in this second position erects the permanent members of the truss that can be handled within the swing of the booms, including the top-chord section between the main posts and the two diagonals completing the triangle AL14 — AU12 — AL10. Under panel point AL10 a temporary steel bent is placed to support this triangle, the bent being imbedded in concrete to above high-water mark, as a protection against ice, etc. As the work of erection progresses from this point, the cantilever and anchor arms are so balanced that the center of gravity of the completed work always lies between the main pier and the temporary tower at AL 10. This tower being securely anchored down is also capable of acting as an anchorage, thus affording an extra factor of safety.

When the work has proceeded this far, the top section of the erecting tower is hung up from the top chords by floorbeams in temporary positions, and the lower part of the tower is taken town. The tower booms then erect the top chord travelers, one for the anchor arm and one for the cantilever arm, taking a large part of the material from the bottom sections of the tower.

These travelers have booms 90 ft. long and a lifting capacity of 100 tons. In addition they are equipped with two 20-ton derricks with booms 80 ft. long, located 15 ft. inside the center line of the bridge trusses. The 20-ton derricks have double booms for convenience in driving pins. The travelers slide forward from panel point to panel point, on runway box girders. They have no wheels, but are fitted with sliding shoes, except in the cantilevering of the suspended span, when rollers are placed under these shoes. This is done as an added factor of safety to prevent any tendency of the traveler to slide forward, or to get out of hand when unclamped and moving.

Material is supplied to the top travelers by derricks situated on the bridge floor. One 100-ton derrick is located over the main pier and one for lighter material at panel AL10, both commanding the gantry yard below. Where possible, material from the gantry yard is picked up direct by the top travelers.

SUSPENDED SPAN CANTILEVERED. — After the main anchorages are in position the traveler on the cantilever arm continues ahead on the suspended span until the whole bridge is completed. Adjustable members are introduced at the end of the cantilever arm, in order that the work may be coupled up at the center. The travelers are adjusted to work on a horizontal instead of inclined chord by means of extra steel members and the rollers mentioned above.

HIGH FLOATING ERECTION.—The suspended span is erected on high steel falsework, the proposed site for this erection being at Victoria Cove, about half a mile below the bridge site. Material for the suspended span is taken from the north gantry yard and transported by water as required. The falsework is erected by gin-poles assisted by a derrick on a scow. The span is erected on the falsework by an inside steel tower traveler having two heavy derricks in front and a light one at the rear. This tower is high enough so that brackets on the top floor level overhang the top chord of the span, and from them the truss members are temporarily hung. When the span is fully assembled and the traveler taken down, the trusses connecting the two falsework towers are lowered from their top position to the bottom of the tower, where they are connected to these towers, thus acting as reinforcement to the pontoons and holding them in their proper relative positions.

The pontoons are floated under the falsework towers in between the temporary concrete piers upon which the falsework is erected. At high tide the load of the falsework and suspended span is transferred to the pontoons which are then towed to the site. Two pontoons are used. Each is 252 ft. by 75 ft., and 13 ft. deep.

LOW FLOATING ERECTION.—Under this scheme, the suspended span is erected in the same manner as for the high floating scheme except that the span is erected on low timber falsework. When the span has been completely assembled the falsework is removed, allowing the span to rest on four concrete piers, in which position it is finally riveted up. At the proper time six scows, three at each end, are floated in, and when the tide rises the span is transferred to these scows and towed into position. From this position it is jacked up into its final position.

The wire suspenders attached to the suspended span are held up in place by wooden falsework, the suspenders being sufficiently slack so that any wave motion will not tend to pick up any corner of the span before all four corners are attached, and the entire weight taken simultaenously by the lifting jacks.

The cast collars that hold the upper end of the wire suspenders are supported on a heavy frame made of girders, which are in turn attached to a chain of lifting plates. These plates are 27 ins. wide and are full of bolt holes, uniformly spaced, so that they can be thoroughly bolted together. The plates lap past each other so that each plate can act as both material and splice, and can also be readily removed as the span is gradually lifted. Each lifting plate has 10-in. pin holes every 3 ft.

On the top of the end of the cantilever arm is a steel box which has a 2,000-ton jack inside of it, and just above it is another steel box similar in design. The lifting plates pass through both of these boxes and at the start of the lifting operations the lifting plate carrying the suspended span is hung from the upper box by means of a 10-in. pin passing through the box and plate. The jack in the lower box is operated by an electrically-driven pump and is designed for a working pressure of 11,000 lbs. per sq. in. with an effective stroke of 3 ft. and a speed of 2 ins. per min. When everything is ready the jack is operated and the load raised 3 ft., or until the pin through the lower box and the lifting plates can be driven and the upper pin withdrawn. The upper box is then lowered until its pin hole comes opposite the next lowest in hole in the lifting plate. This pin is then driven and the lower pin withdrawn, the jacks again operated, thus completing a cycle. As sections of the lifting plates are released, they are disconnected and by means of the traveler are lifted out of the way.

The lifting operation proceeds at all four corners of the suspended span simultaneously. When the span is fully raised the final pins can be driven as the pin holes in the cast collars are not used during the raising.

A safety device is provided to safeguard the raising operations. It consists of four screws at the four corners of the lower box, driven by an electric motor operating through equalizing gears. These screws are always bearing against the upper box, and as they are capable of sustaining the whole load, the temporary failure of the lifting apparatus would have no serious result. These screws can also be used for quickly lowering the upper box after each operation.

After the load of the suspended span has been transferred to the lifting jacks the scows can be released and all lines and anchors cleared from the river. It is estimated that the span can be lifted and connected in two working days. Many of the special appliances proposed by this firm in connection with the erecting of this bridge have been patented. The scows used in this scheme are each 257 ft. by 38 ft. and 10½ ft. deep.

St. Lawrence Bridge Company.

The St. Lawrence Bridge Co., in addition to tendering on each of the Board's designs, submitted seven different alternate designs, as follows:

Design A.—This corresponds to the Board's design with respect to panel lengths, height over main pier, profile of bottom chords, and floor system. It has an anchor arm of twelve panels and a suspended span designed for floating erection, corresponding to Design V. of the Board. The Board's design has been departed from in respect to the type of web system, the substitution of built-up tension riveted members for eyebars, and as regards the outline of the top chord of the cantilever arm and the suspended span. There are also various changes in the design of many of the members.

Design B.—This is the same as Design A, with the exception that carbon steel instead of nickel-steel is used for the vertical posts in the cantilever arm, three panels away from the center pier, as well as for all members in the anchor arm. The details of members and type of web system remains unchanged.

Design C.—This design is identical with Design A, except that nickel-steel eyebars are used throughout, instead of built-up riveted tension members.

Design M.—This design retains the single intersection of the Board's design, and follows very closely the general features of the design submitted by Maschinenfabrik Augsburg-Nuernberg. The anchor and cantilever arms are each 522 ft. long with a suspended span of 714 ft. In this

design nickel-steel is used throughout. The details of the main members have been somewhat changed from those prepared by the Board. Pin bearings are employed throughout for all abutting joints of compression members.

Design N.—This design is identical in outline with Design M, the only difference being that carbon steel is substituted for nickel-steel in a number of the members. This change was made with the idea of effecting a slight economy in design.

Design X.—Design X is similar in outline and general details to Design A, but is intended to accommodate railway traffic only, the tramway and highway roadways being omitted. A 4-ft. walk is allowed for on each side for the use of inspectors, etc. Carbon steel is used for the anchor arm, members over the main piers, and for the vertical posts of the cantilever arm for three panels from the pier. Carbon steel is also used for the center posts of the suspended span.

Design Y.—This corresponds to Design X as Design C compares with Design A. Here railway traffic only is provided for and nickel-steel eyebars are used instead of riveted built-up tension members.

SCHEME OF ERECTION.—Several different schemes of erection are proposed, for the suspended span as well as the cantilevers. These schemes are in the nature of studies, the final choice being subject to the design upon which the contract might be awarded, and to approval by the Board. They include the following elements:

(a) Erection of the anchor arm on steel falsework before starting the erection of the cantilever arm. In this scheme the anchor arm will be assembled and riveted up complete before moving ahead. An inside traveler is used and is operated from the floor level (see Fig. 6). This scheme can be applied to both the Board's and the contractor's designs.

(b) Erection of the anchor arm and the cantilever arm concurrently. The first step in the erection is the construction of a high tower on piers between panel points AL12 and AL14. This tower has overhanging arms from which the trusses on either side can be reached. From this tower the anchor arm is erected up to AL10, under which point a temporary masonry pier is built, which acts both as a supporting pier and an anchorage (see Fig. 5). After the floor has been put in place the tower is taken apart at the floor level, the upper part being used as an inside traveler, with which the remainder of the anchor arm is erected. The erection of the anchor arm is always sufficiently in advance of the cantilever arm to ensure that the center of gravity is always between AL10 and the main pier. A falsework trestle for the handling of material connects the shore with the work under construction. This scheme of erection can apply either to the Board's design or the alternative designs.

(c) Erection of the cantilever arm by inside traveler, similar to that used for the erection of the anchor arm. In the case of erection scheme (a) the traveler used for the anchor arm is moved ahead on the cantilever arm and the erection proceeds, panel by panel, until this part of the bridge is entirely completed. In the case of erection scheme (b) the traveler for the cantilever arm is erected by the traveler used for the erection of the anchor arm when the erection of this arm has proceeded past panel point AL10, thus ensuring stability for the further progress of the work. From this point and to the end of the cantilever arm, the erection of schemes (b) and (c) are exactly similar.

(d) Erection of the cantilever arm with a top-chord traveler. This traveler is erected by the inside traveler of the anchor arm. This scheme of erection is intended to apply to the Board's design only (see Fig. 5).

(e) Erection of the suspended span by cantilevering. This erection is done with a small top traveler in practically the same manner as is proposed by the other bidders. This scheme of erection applies only to Designs I. and IV. of the Board.

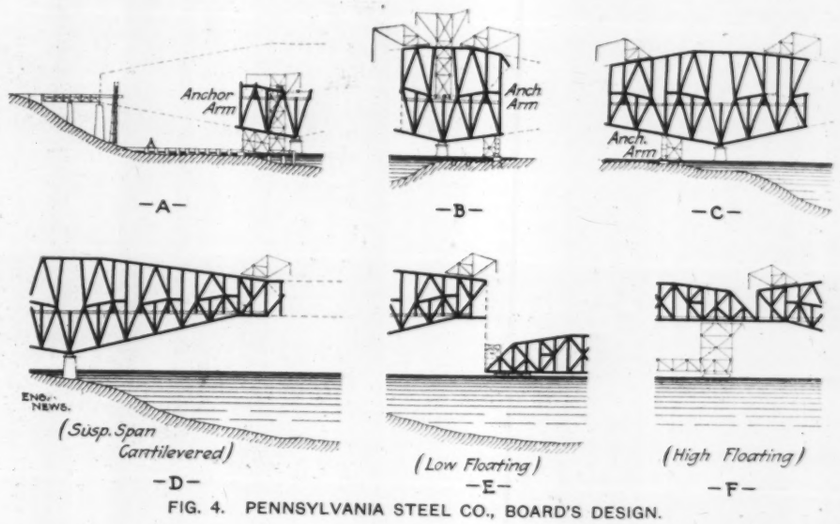


FIG. 4. PENNSYLVANIA STEEL CO., BOARD'S DESIGN.

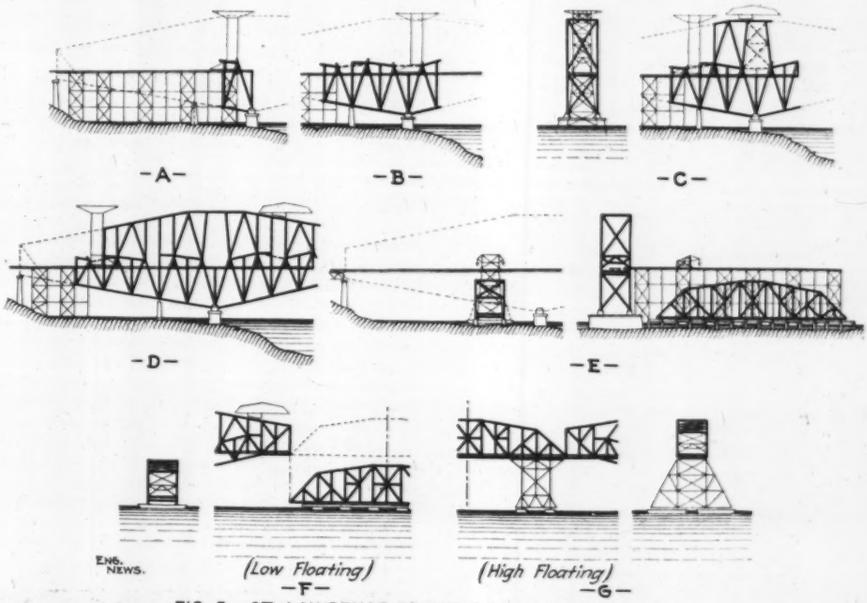


FIG. 5. ST. LAWRENCE BRIDGE CO., BOARD'S DESIGN.
(Project for erection of cantilever arm by top-chord traveler.)

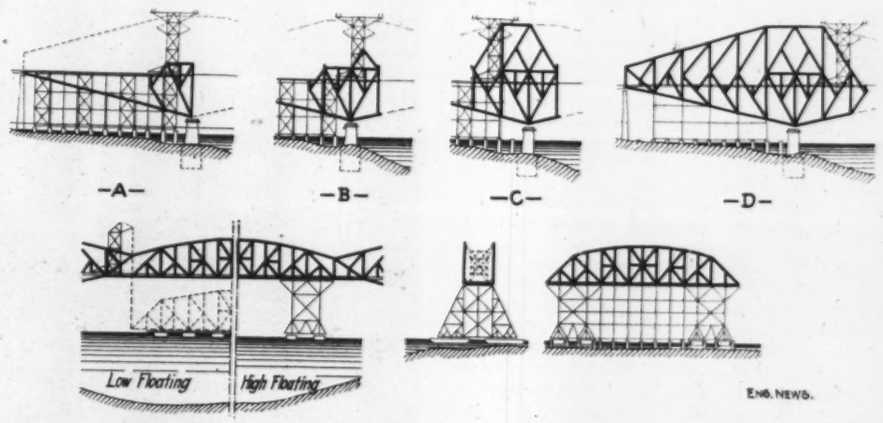


FIG. 6. ST. LAWRENCE BRIDGE CO., BIDDER'S DESIGNS A, B & X.

(f) Suspended span floated in on high falsework. The falsework for this scheme of erection is constructed on concrete piers and is located on the shore directly at the bridge site. The suspended span is laid down at right angles to the bridge proper and one end is hard up against the anchor arm at almost a point corresponding to AL10. A traveling crane takes the material, both for the falsework and the suspended span, from the cars on the bridge and carries it to whatever point it is required. Eight pontoons 120 ft. by 36 ft. by 12 feet deep are used. At high

tide the falsework is lifted off the piers and towed into position.

(g) Suspended span by floated in on low falsework. The erection of the suspended span in this case is carried out as in the preceding, except that the span is erected directly on the piers. For floating, six pontoons are required, each 238 ft. by 38 ft. by 10 ft. deep. After being towed into place the suspended span is lifted into place by means of hydraulic jacks and wedges operated by power. Both schemes (f) and (g) can be employed for either the Board's or the contractor's designs.

ADOPTED PLAN.—Design X is the one which was finally approved and contracted for. It provides for railway traffic only. The top chord and other tension members will be built-up instead of eyebar members. The channel span is 1,800 ft. The design was shown and described in our issue of April 20, 1911.

The anchor arm will probably be erected on falsework, and the cantilever arms by inside traveler. The suspended span will probably be built on high falsework and floated into place.

According to the specifications the Government will stop navigation on the river during the progress of floating in the suspended span and will furnish free of charge the motive power required for towing the span into position.

Pneumatic Hammers for Tearing-Up Street Pavements.

By FRANK RICHARDS,* M. Am. Soc. M. E.

A job of all too frequent occurrence is the tearing up of street pavements for the laying or changing of rails, pipes, wires, etc. It is always hard work, and in the way in which it has generally been done by hand it has been also costly and in many respects unsatisfactory. Fig. 1 shows how this work has recently been done on an extensive scale in the streets of Zurich, Switzerland, by the use of pneumatic hammers. The City Tram Co. of Zurich had miles of track to relay, and as the rails were bedded in concrete it was necessary to tear this up for a certain distance outside the rails and all of it between the rails. The track gage as given the writer is 3 ft. 3 ins., but is probably one meter. The data for the account which follows I have received from Mr. J. Waldenberg of Düsseldorf, Germany.

The portable compressor outfit used was mounted on a special flat truck with four wheels of wide face and long plate springs for the axles. The 8 × 8-in single-stage compressor was belt-driven by a 550-volt D. C., 21 HP. motor, the belt having a tightener actuated by a lever and weight. A vertical air receiver and a water tank of about 18 cu. ft. capacity were provided and a tool box was attached below the truck frame. The tools used in connection with this air supply were four heavy chipping hammers, equipped with round bushings.

On each side of each rail, the workmen tear away by means of these hammers strips about 6 to 8 ins. wide, thereby freeing the rails from the concrete, which is about 10 ins. thick. After these strips are cut away, solid pieces of concrete 10 to 20 ins. long are lifted by crowbars from between the rails, also from between the rails and the sidewalk. It is then an easy matter to break up these large blocks with sledges.

The chisels or picks used in connection with the hammers were made of ordinary machine steel, as the company found out by experience that it does not pay to use a good grade of tool steel for this kind of work. When made of hardened steel, the chisels break much easier than if soft steel is used, the breaks occurring in the shanks as well as at the points. The shanks are round and the points are chisel shaped, the chisel being tapered down with a long slant at the sides so that the straight cutting edge is only about ¼-in. wide. This shape proved to be the most satisfactory, as if made with a point the bits broke in a very short time regardless of the material of which they were made.

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Fig. 1. Breaking Up Concrete Pavement With Pneumatic Hammers at Zurich, Switzerland.

Four men, each operating a pneumatic hammer, would accomplish about as much work as 16 to 20 men working entirely by hand. One pneumatic hammer therefore takes the place of from four to five common hand-hammers and chisels. One man can cut with one hammer per hour a strip 8 to 10 ft. long, and as the strip is about 8 ins. wide the average work for one pneumatic hammer per hour is about 5.3 sq. ft. This capacity refers to work in solid, hard concrete. It is to be taken into consideration, the writer is informed, that the workmen in Zurich do not exert themselves too much, being employed by the city and being entitled to minimum wage regardless of the amount of work done. On the other hand, of course, the interest and depreciation on the plant, the cost of transportation, power consumption, etc., would have to be considered in making a fair estimate of the advantage gained by the use of the pneumatic outfit.

CUTTING ASPHALT AND MACADAM.—It is to be remembered that the work at Zurich above described was the cutting of concrete. In entire ignorance of this operation there has been developed almost simultaneously by the Brooklyn Union Gas Co. at Brooklyn, N. Y., a quite similar application of the pneumatic hammer, but in this case for cutting asphalt pavement. Those who have seen the operation of breaking up or breaking into an asphalt street pavement by the old methods will realize not only the strenuousness of the task but also the difficulty of following any precise lines of cleavage. The method of cutting asphalt with the pneumatic hammers is shown in Fig. 2. A chalk line is marked on the surface and the chisel follows it exactly, turning the asphalt over as if it were leather, although in hardness and tenacity it is more like copper or iron. In this case, the hammers were used for breaking up the surface where a 4-ft. gas pipe was to be laid through the street. Mr. E. J. Byrne is chief engineer of District No. 1, in which the work lay, and Mr. E. D. Jones and Mr. John E. Setchell were the assistant engineers in immediate charge of the work.

The portable air-compressing outfit was mounted on a truck similar to the one used at Zurich, but here the compressor was driven by a gasoline engine. A 2-in. iron pipe was laid on the surface of the pavement close to the curb and was connected to the receiver of the compressor. The tools could then be connected at various points along the pipe, obviating the necessity of frequently moving the compressor as the work progressed. There was here as well as in Zurich some experimenting as to the best hammer to use, the one finally adopted being of a type extensively used in coal mines. The cutting tool was like a big chipping chisel, an inch and a half wide. This was run along the two lines defining the width of the trench, cutting through the asphalt and giving it a turn partly over as a plow would do. The sheet of asphalt was then pried up by a crowbar gang, while one man would break it with a sledge.

Some data of the actual rate of cutting the asphalt with the pneumatic hammers are furnished the writer by Mr. John E. Setchell as follows:

From observation of about 3,000 linear feet of cut (1,500 ft. of trench), with two men and sometimes three using the hammers, the average asphalt cut was 20 ft. per man per hour.

On June 1, 1911, on a 45-minute hand test (hand-held chisel and sledge) we cut at the rate of 12 ft. per man per hour, but the men were exhausted and had to stop.

The material under the asphalt was macadam, close and hard, and for breaking up this also the "coal picks" did good service. The chisels were exchanged for pointed picks for this work.

FIG. 2. CUTTING AN ASPHALT PAVEMENT ON TWELFTH ST., BROOKLYN, N. Y., WITH PNEUMATIC HAMMERS.

(The slice marked out by the hammers was subsequently broken up with crowbars and sledges.)

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Brick Paving for Country Roads.

Several years ago we described an experiment made in Illinois with the use of brick paving on country roads, and at that time we pointed out the advantages which that construction offered at points where there is a concentration of heavy traffic. Since that time there has been a gradual development of the system, and elsewhere in this issue we give some particulars as to work in Illinois and Ohio.

In the first experiments, cheapness was one of the principal objects striven for, in order to keep the cost within the funds available and to avoid objections from local authorities who might assume that the work was to be similar to that of street paving. A light gravel base and the use of plank curbs to hold the brick in line were features of some of the early work. While brick paving is good for traction it is likely to make a hard riding road for vehicles moving faster than a walk, and it is not so good for horses as a softer surface. For these reasons, as well as for the purpose of reducing the cost (and extending the cost over a greater length of road) it has been general practice to lay the brick paving for only about half the width of the road, leaving an earth or gravel strip for use by lighter traffic and in fine weather. But as such paving is mainly important where the traffic is heavy, the present tendency is to use a concrete base and curbs of concrete or vitrified block to hold the brick in position. These curbs are laid flush with the surface of the brick, so that vehicles can drive on and off the paved strip at will. If the traffic is light, a gravel or macadam paving may be used to replace the common earth, which latter is likely to become almost impassable in bad weather.

Heavy traffic of two different classes may render brick desirable, especially when it is considered that as a general thing proper maintenance of a country road is an impossibility under present methods of administration. In the first place, a heavy traffic of heavily loaded vehicles, which makes a hard road desirable, may lead to the rapid wear and disintegration of macadam (however well built); in the second place, the same effect may be produced if a large portion of the heavy traffic consists of automobiles. In fact, it has been estimated that nothing but a paving such as is afforded by brick or concrete can stand heavy traffic of this latter class. The paving brick interests are recognizing this as a new field for their product, and are taking steps to convince local authorities (as well as engineers) of the advantages of brick paving along earth roads in order to permit of traffic being handled regardless of weather conditions.

Water-Supply Shortages and Their Prevention and Amelioration.

The exhaustion of the water-supply of Dallas, Tex., not long since, and of Charlotte, N. C., only a few days ago, together with the present shortage at Baltimore, Md., which has compelled many people to choose between muddy water or none, as well as the threatened exhaustion of the supplies of New York City and various smaller places in the northeastern part of the country, all point to the necessity of a more far-seeing provision of water storage or of supplies from additional storage where dependence is had upon streams of limited dry-weather capacity.

Most if not all of these cities had ample warning of their danger but gave it little or insufficient heed until disaster was close upon them. Conditions at Dallas are reviewed elsewhere in this issue, while those pertaining to New York have been pointed out repeatedly in these columns within the past few months.

Charlotte, which on July 31 found itself largely if not wholly dependent on water brought in by rail and wagon (although it had an emergency pipe line nearly ready) was advised by the Committee on Fire Prevention of the National Board of Fire Underwriters, in April, 1907, that:

> The sources of supply, as at present developed, are not sufficient to provide for consumption during a period of protracted drought.

Whether or not any action followed this advice prior to extreme low water this summer we cannot say, but if so it was inadequate. In consequence, the city has suffered materially and might have been destroyed by fire had a conflagration occurred.

That the people and city officials of Baltimore knew of the need of more water storage is attested by the fact that steps to secure it were taken some years ago, when money was appropriated, land contracted for and perhaps plans made for a new reservoir. Unfortunately the project was held up by a bitter local controversy over alleged land "deals" and other matters. Whatever the merits in this case, this controversy engaged public attention when officials and citizens alike should have been using all their energy in securing additional water storage and needed purification works.

The general public does not realize, except as enlightened by engineers and intelligent laymen who are willing to take the advice of engineers, that it is the abnormally dry year, and not the average year, which must be the basis of calculations for water-supplies; much less does the general public realize that once or twice in a century a drought exceeding the recollection of the "oldest inhabitant" may occur.

While it may be economically and even physically impracticable to provide against the maximum freshet which may be expected at intervals of fifty or a hundred years it is not only imperative but in most cases it is relatively easy to safeguard life, health and property against the worst evils of the most extreme drought on record.

In the case of freshets one deals with great forces of nature at their greatest. In the case of drought, nature is at its lowest ebb and, especially in cities, only a small part of the deficiency need be supplied to avert the worst dangers that are likely to come.

The point we wish to make may all be summed up in a paraphrase of the maxim, "in time of peace prepare for war." So, in time of water plenty, prepare for drought; and (to amplify) let your preparations include plans for the direct emergency that may overtake you in case nature hastens or man delays and thus, through no fault of yours (as water engineer or official) your well-laid plans for always maintaining an ample supply should not be executed when the unexpected but ever-possible drought occurs. That is, make at least tentative outline plans for a few quarts per capita per day of absolutely safe drinking water; plan, with the fire and police departments, extreme emergency measures against fire; and also plan, with the health and other city departments how to obviate or reduce the great nuisance, but slighter danger to health than many think, that would arise if a community long dependent on a sewerage system were suddenly deprived of water for flushing water closets and thus thrown back on primitive means of disposing of excreta.

The main thought and effort of the water engineer and other responsible city official, we hardly need say, should be put upon rendering the need for any such extreme emergency measures as we have just suggested quite unnecessary, as can be done in 99 cases out of a 100.

Grade Crossing Accidents.

As is usual in the summer months, when the pleasure-trip season for motor cars is at its height, a large number of automobiles have recently come to grief in grade-crossing accidents. Three typical cases are the accidents at Raceville, N. Y., Wilkinsburg, Pa., and Winfield, N. Y.

The accident at Raceville, a little town near the New York-Vermont state line in the vicinity of Lake George, occurred July 17 at a crossing protected by neither gates nor flagmen, but not considered particularly dangerous, nevertheless, because of the unobstructed view of the tracks. The driver of the car, a professional chauffeur, saw the approaching passenger train but attempted to cross the track ahead of it. This he could probably have done had not a very natural anxiety to get quickly under way impelled him to shift from a lower to a higher gear ratio too soon. As a result, his engine was stalled, bringing the car to a standstill directly on the track. Four women in the car were killed and the chauffeur was seriously injured.

The accident at Wilkinsburg, a Pittsburg suburb of about 20,000 inhabitants, occurred July 27 at a crossing on a city street protected by two flagmen but without gates, although there are a number of different tracks from the railway yards crossing the street. The driver, who was the owner of the car, had come to a stop to wait for a slowly moving freight train to go by. As soon as the locomotive of the backing train had crossed the street, he started his car across the tracks only to find himself in the path of an express train, sight and sound of which had been hidden by the freight. The excited warning of the flagman was misunderstood or seen too late. Four persons in the car were killed and the fifth fatally injured.

The Raceville accident is typical of a large class in which a good share of the blame may be put upon the automobile driver, but this is hardly the case in the one at Wilkinsburg. Perhaps both these accidents could have been prevented by crossing gates—if the gates were intelligently operated.

But the installation of crossing gates is not always a solution of the problem. The Winfield accident (July 24) occurred at a crossing protected by gates operated by a man stationed at the crossing. Winfield is a small suburb of Long Island City, but Thompson Ave., where the accident took place, is one of the main highways of travel for motorists from Long Island points to New York City. Consequently the circumstances preceding the accident are of daily, even hourly, occurrence. The gates had been lowered for the passage of a freight train, and four automobiles had come up from the same direction and stood in line with engines running

idle waiting for gates to be raised. The freight train passed, the gates were raised, the motor-car drivers threw in their clutches and their cars advanced to cross the tracks. The first car got across and the fourth was stopped in time, but the second and third cars were hit by an electric express train that came around a curve at about 30 miles per hour. One man was killed and two women were severely injured. The aged gateman did not see nor hear the express in time. He had supposedly been notified of its approach by an electric signal manually operated by the gateman at the next previous crossing, but is reported to have denied receiving this signal.

These three accidents have one element in common which puts them in an entirely different category from those discussed in our issue of Sept. 16, 1909. There the automobiles were hit while crossing the track at high speed, but here they were at low speed, just starting in fact. Warning signs, set up 100 yds. or more from the crossing in each direction, might be expected to considerably decrease the number of accidents of the former type, but would be of no use at all for the latter. Perhaps it is out of the question to install gates at every grade crossing, and at those where the traffic both by rail and highway is comparatively light the signs alone should suffice. But it seems clear that the only way to be reasonably certain of preventing grade-crossing accidents, particularly where the conditions are those that exist now at Winfield, Long Island, and at hundreds of other points throughout the country, is to eliminate the grade crossings.

The Cause of Occasional Low Elastic Limit in I-Beams; What is the Practical Meaning of Elastic Limit?

Considerable discussion was aroused two years ago by the report of a series of experiments by Prof. Edgar Marburg on I-beams of different sizes* which seemed to show that the metal at conjunction of flange and root in some instances had surprisingly low elastic limit (true limit of proportionality). Strips cut from web, flange and root, respectively, were tested in tension, and, while the web and flange pieces gave fairly normal results, some of the root pieces showed a bend in the stress-strain line at values as low as 10,000 to 13,000 lbs. per sq. in. There was no agreement as to what causes might have produced this condition, but the impression conveyed was that deficient rolling pressure at this point of the beam section had left the metal in a state of poor structure or in a porous condition. Prof. Marburg's tests also included bending tests of I-beams, in some of which similar low elastic limits were observed. The tests carried the suggestion that some I-beams are not in fit condition to carry even the ordinary working loads assigned to them, let alone having a satisfactory margin of safety above such loads.

Prof. E. L. Hancock worked on this subject by experiments immediately thereafter, and reported some results at the 1910 meeting of the American Society for Testing Materials.† The tests of Prof. Hancock did not reveal any marked cases of low elastic limit, nor was there a preponderance of cases in which the lowest elastic limit occurred in the root as compared with the flange and web. However, his results did show some values of elastic limit considerably below what ought to be expected. There was no indication of an explanation for the occurrence of these cases. More recent work by Prof. Hancock, reported at the 1911 meeting of the Society under the title "Strength of Steel from Structural Shapes," seems to clear up the subject measurably.

As to chemical composition: Chemical analysis of samples from web, flange and root of a large number of I-beams showed a very satisfactory uniformity in the chief alloying elements, carbon, manganese, phosphorus and sulphur. There was no difference between the analysis of root samples and that of web and flange samples to account for notably different physical properties. These analyses covered beams from 6 to 24 ins. deep (two of them being Bethlehem beams rolled in the Grey mill, which class of beams had been placed particularly under indictment by Prof Marburg's paper). It is evident from these analyses that the physical differences must lie in causes other than chemical composition.

Next came the question whether the abnormal elastic qualities occasionally noted are attributable to the effects of work in rolling, and difference in finishing temperature. Most of the attempts to explain low elastic limit* of the root portion of I-beams were based on the fact that this part of this section, being less directly exposed to the pressure of rolls, received less mechanical working in the rolling process and for this reason would have lower strength qualities; and that, further, as the metal at this point would cool more slowly than the rest of the section, it would get its final working at a higher temperature, which also would tend to give lower strength.

It is to be borne in mind that the tests of Prof. Marburg, as well as those of Prof. Hancock, showed no decrease of ultimate strength or of elongation and reduction of area in the pieces of abnormally low elastic limit. What is still more surprising, the yield-point of these samples was practically the same as that of other samples. But if amount of working or finishing temperature were determining factors in the case, these physical properties should be affected, and not merely the limit of proportional deformation. The fact that they are not seems to rule out the explanation based on variations in amount of working and finishing temperature.

Furthermore, if such explanation were applicable, the differences in elastic limit should in all cases point in the same direction, since the factors in question are active in the rolling of every single beam. The root portion of every beam, therefore, should show distinctly lower elastic limit than web or flange test samples. This is not found to be the case. In Prof. Marburg's tests, only three beams out of five showed lowest elastic limit in the root; in the other two, the flange had lowest elastic limit. Prof. Hancock's tests of last year showed only five tests out of eleven where the elastic limit of the root sample was markedly lower than that of root or flange samples; some of the other six tests showed substantially equal values for flange, root and web, and in other cases the flange or the web samples were the lowest by a distinct margin. No rule can be drawn from these results to place the blame for low elastic limit upon rolling work or finishing temperature. While these factors undoubtedly have some influence, it is not of sufficient amount to influence the results for practice.

Taken together, all of the tests reported show not only occasional low values of elastic limit but more prominently still a very great irregularity of elastic limit. This condition is unexpected in a material of recognized uniform characteristics and of marked regularity in yield-point and ultimate strength. But, as bearing upon this observation, it is noted that steel which has been stressed beyond its yield-point usually shows a lowered true elastic limit thereafter, although the yield-point is not lowered and may even be raised. That is to say, the stress-strain line of such overstrained steel shows a bend in the normal straight section below the yield-point. It has also been found that this effect is removed by heating, and disappears of itself in time. Prof. Hancock directed a series of tests to the purpose of finding whether this overstrain phenomenon could be the explanation for the observed irregularities and abnormalities of elastic limit in I-beams. His results demonstrate pretty conclusively that the explanation does lie here.

In testing five I-beams, three channels, and one angle, for physical properties of material in web, flange and root, the elastic limit was more regular than in the tests previously mentioned. In a few instances, low elastic limit was coupled with the observation of strain lines on the outside of the beam. Such strain lines are produced by the gagging to which beams are subjected in the mill to straighten out short kinks after rolling. The local overstrain cracks the mill scale and also produces structural lines in the metal, which result in the development of rust along these lines when the beam is exposed to the weather, so that on a lightly rusted I-beam the strain lines are distinctly marked out. Since portions of metal showing such strain lines were at some time strained beyond their yield-point, the phenomenon of lowering of elastic limit ought to result at the points in question.

The accompanying photograph shows three beams, on two of which strain lines show on the web, while the upper one is reported as having strain lines all along both flanges. The beams were so old that it was supposed the metal had already recovered from the local overstraining, hence showed less marked abnormalities. They were all three, therefore, subjected to new overstrain by bending by central load, this bending being carried far enough to cause scaling at the center. Thereupon 18-in. test strips were cut from web, flange and root at the middle of the beam and also at the end of the beam, and tested in tension. The results are given in Table I. herewith, rearranged from Prof. Hancock's figures.

TABLE I.—RESULTS OF TENSION TESTS OF STRIPS CUT FROM 10-IN. I-BEAMS AFTER OVERSTRAINING BY BENDING.—(Comparison of Strips From Middle of Length of Beam and Strips From End of Beam.)

Test piece.		Elastic limit, M-lbs. per. sq. in.	Yield-point, M-lbs. per. sq. in.	Ultimate strength, M-lbs. per. sq. in.	Elongation in 8 ins.	Reduction of area.
Beam 1.						
Web,	end...	32.0	36.6	57.7	30.0%	62.2%
	middle	30.0	35.6	63.3	29.5%	66.0%
Flange,	end...	28.0	33.1	57.8	30.0%	64.2%
	middle	16.0	32.2	58.1	29.0%	58.7%
Root,	end...	28.0	33.5	58.0	30.0%	62.5%
	middle	14.0	29.5	57.2	.....	62.8%
Beam 2.						
Web,	end...	32.0	36.2	58.1	32.0%	60.0%
	middle	30.0	35.2	57.7	30.0%	63.3%
Flange,	end...	20.0	30.9	58.0	25.5%	62.3%
	middle	28.0	31.8	58.3	25.0%	60.0%
Root,	end...	20.0	33.3	59.1	25.5%	58.0%
	middle	22.0	37.6	60.0	24.4%	58.7%
Beam 3.						
Web,	end...	32.0	36.0	58.4	29.5%	58.0%
	middle	28.0	35.1	59.5	29.5%	62.8%
Flange,	end...	24.0	33.4	58.6	26.0%	60.2%
	middle	14.0	35.7	58.2	22.0%	62.0%
Root,	end...	28.0	32.0	59.2	23.5%	63.0%
	middle	16.0	38.3	59.7	22.0%	61.2%

The figures exhibit very clearly the strong influence of the overstrain upon the flange and root pieces from Beam 1 and Beam 3. The elastic limits of the flange and root pieces cut from the center of the beam are seen to be markedly lower than those from the end of the beam. The end of the beam, of course, was not overstrained by the bending and, as the results indicate, the web was not overstrained even at the center. The beams were 10-in. 25-lb. standard I-beams (minimum section), and the tests were made about one month after the overstrain by bending. In Beam 2, some recovery actions must have been at work to conceal the lowering of elastic limits.

As a further check upon the explanation advanced, test-pieces cut from the flange at midlength of these same three beams, but out of the flange opposite the one from which the samples reported in the above table were taken, were treated for restoration of elastic limit by heating to 1,600° F. and slow cooling. For the two test-pieces corresponding to the flange strips of Beams 1 and 3 the figures, after treatment, were 24,000 and 26,000 lbs. per sq. in. (against 16,000 and 14,000), showing that the heating had largely cured the abnormality. As this is precisely what occurs in the case of overstrained metal, there is every reason to believe that the abnormalities of the above table are due to overstrain, and further that the exactly similar abnormalities found in some I-beams as bought are due to the same cause.

*Eng. News, Aug. 12, 1909, p. 168.

†Eng. News, July 7, 1910, p. 28. Tests by Prof. H. F. Moore are there reported also.

*Throughout, the words "elastic limit" mean "limit of proportional deformation," i. e. the point where the stress-strain curve departs from a straight line.

Similar evidence was obtained by making tests on new samples cut from beams from which tests had been taken in 1910, in order to see whether the year's rest had resulted in any restoration of elastic limit. A beam section which showed 13,500 lbs. elastic limit in 1910 showed 22,000 in 1911; another, 16,500 in 1910 and 24,000 in 1911. It is to be understood that these were independent samples cut in each case from the flange opposite the one which yielded the 1910 test-piece. Here there had been no intentional overstrain by the experimenter. Evidently the original condition of the beams as procured was one of overstrain locally.

Tests made on samples cut from an 18-in. 55-lb. I-beam at two places, one where the beam had been gagged heavily, the other at a point where no gagging had been done, showed uniformly lower elastic limit for the pieces from the gagged section. The yield-point, ultimate strength, and reduction of area were uniform, as expected; the elongation was slightly reduced in the gagged portion.

Prof. Hancock's conclusions from this work are expressed as follows:

(1) The tensile strength, percent elongation and percent reduction of area are practically not affected by chemical composition or by treatment during or after rolling; the yield-point is affected but slightly; the elastic limit is affected, but not seriously when the proper precautions are taken.

(2) The chemical composition of open-hearth beams is so uniform throughout the beam as to cause no practical difference in the strength of metal cut from different parts of the profile of the beam.

(3) If all parts of the profile of a beam were finished at the same temperature, it would be expected that the root of the web would have a slightly lower elastic limit than the center of the web of the flange, because of the smaller amount of work done upon it in rolling. But the flange and web, being thinner, are finished at a slightly lower temperature than the root and so have their elastic strength increased still more, due to this lower temperature. The web probably received more work than the flange in rolling.

(4) Overstraining structural shapes lowers the elastic limit of the metal, but not permanently, the elastic limit returning to and above its original value when the material is allowed to rest. Cold straightening of beams probably accounts for some low values of the elastic strength obtained by recent investigations. The evidence of recovery should give confidence to the users of these materials.

These conclusions seem to be satisfactorily supported by the test material which he has analyzed (and in large part himself provided). The last sentence of the above quotation, namely, that "the evidence of recovery should give confidence to the users of these materials" may indeed require very much stronger stating. It has not as yet been shown what relation, if any, the "true elastic limit" or limit of proportionality of a piece of steel bears to the service value of the beam or other piece of material, and it may very well be argued that, provided the yield-point and ultimate strength are not altered, the lowering of elastic limit is unimportant. Combining herewith the fact that any lowered elastic limit is restored by a rest of several months to a year, Prof. Hancock's work may perhaps be regarded as finally disposing of the question raised two years ago.

However, aside from the particular matter of I-beams, the question of the practical meaning of "true elastic limit" ought to have full consideration. Experimenters engaged in research by the testing-machine are apt to make much of "elastic limit," and, if anything, the tendency in this direction is increasing. On the other hand, designing and constructing engineers continue to look upon the "yield-point," or as it is often called the "commercial elastic limit," as the effective boundary of elastic behavior for their purposes. When fixing permissible stresses or passing upon the safety of a structure they pay little attention to those divergences from the straight-line relation of strain to stress which occur below the yield-point.

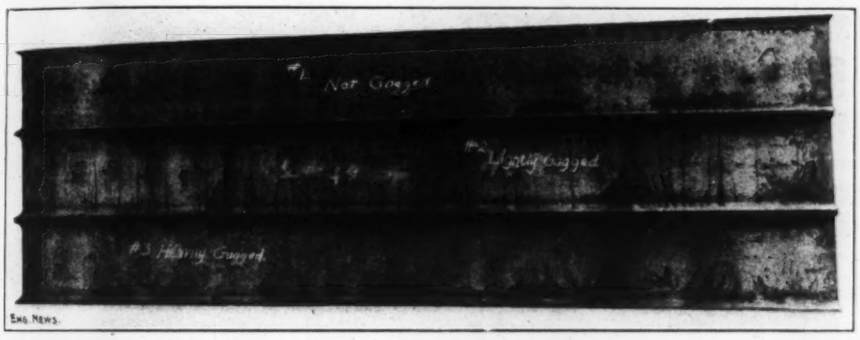
Of course we speak here only of steel, metal which has a pronounced yield-point. A tension test-piece of ordinary steel will show a remarkably straight stress-strain line, suddenly curving off to a pronounced elongation at the yield-point, say at 33,000 lbs. per sq. in. The skilled tester, with delicate procedure, is able to detect a slow curving away from the straight line at loads as low as 27,000 lbs. per sq. in. As he interprets it, the metal is perfectly elastic up to this 27,000, and partly plastic at all higher loads, the yield-point being merely an incident in the plastic state.

Of course, so long as the relative positions of "true elastic limit" and yield-point remain constant, a given quality of metal may as safely be judged by the one as by the other. But the fact is that certain conditions can lower the "true elastic limit" while leaving the yield-point unaffected. For example, in some of the I-beam tests above referred to, the yield-point remained at its value of 30,000 to 35,000, but the "elastic limit" was only half its normal value. The important question is, Does such a piece of metal have only half the available strength of a normal piece?

The question is not one to dogmatize about. But to tell the truth there is no definite knowledge as to the effect of lowered "elastic limit" upon service qualities. When the yield-point shifts position with regard to ultimate strength, we know that the ductility changes also, and so we are able to judge when it is best to use metal of low yield-point, and when to use metal of high yield-point. But whether the shifting of "true elastic limit," with respect to either yield-point or ultimate, means anything at all, and if so what it means, are open questions.

Many factors require consideration in connection with this subject. Hardening effects due to stressing, endurance under repeated loading, set, time effects, etc., are involved. At the same time separate study must be given to integral pieces of material and composites (as, built columns, girders and trusses). The nature of the stresses, and the relation of strains to the structural make-up is also important; thus, a column may be more susceptible to injurious effect of low "elastic limit" than an I-beam or an ordinary truss. Before a final answer can be given on the basis of all these considerations, much more experimental work will have to be done.

But on the basis of present evidence, we feel that more importance is given to "true elastic limit" than the facts warrant. There is little justification for the contempt felt in many quarters for the old-fashioned yield-point. Steel whose ultimate strength, ductility and yield-point are good should be accepted with fair confidence irrespective of delicate determinations of "elastic limit," at least until plausible reasons to the contrary are brought to light.



THREE 10-IN. I-BEAMS; STRAIN LINES SHOWING OVERSTRAIN PRODUCED BY GAGGING.

(The upper beam, while showing no lines on the web, is reported to have exhibited strain lines all along the flanges.)

LETTERS TO THE EDITOR.

The Ventilation of Sleeping Cars.

Sir: The abstract of the paper, "A Study of the Ventilation of Sleeping Cars," appearing in Engineering News, July 6, is very interesting and is the first data the writer has ever seen on the subject. The paper is very thorough and the author has evidently spent a great deal of time and study on the subject.

While the air in Pullman cars is probably not as bad as that of elevated cars, etc., the former, no doubt, has caused more ill-health and misery due to the longer periods a traveller is compelled to occupy them. For about ten years the writer has been compelled to use sleeping cars as often as three nights a week and, although a heavy sleeper without the slightest trouble in sleeping during the whole night, for a long time in the winter months never got off the train without feeling as if he had not been to bed at all—in fact, would have felt better if he had not. In the summer time no trouble was experienced at all and the condition could have been due to nothing else but the foul air.

Being in the ventilating business, the writer finally looked around for a cure and hit upon the idea of raising the inside and outside window at the foot of the berth and inserting a folded newspaper under them, which leaves a good sized opening for fresh air. This has done away with frequent colds and attacks of grippe which were caused by foul air. In zero weather I have gone into the dressing room feeling fresh and well rested, after a night with the window fixed as mentioned, while all around were men complaining of the cold car and of lack of sleep. It is well understood how a person can be comfortable at a much lower temperature with fresh air than you can at a higher temperature where the "life" has all been taken out of it. Several of my friends have tried the same thing and find the same results.

Now, the only proper solution of this trouble of foul air is an indirect heating and ventilating system with ducts discharging into each berth a given amount of tempered air every minute. Its adoption would not be a difficult matter and it would be the means of doing away with the monitor on the tops of the cars, which car builders seem to think are as necessary to a car as a steeple to a church. Abolishing the monitor would give a larger berth to each person.

Yours very truly,

"Fresh Air."

Chicago, July 21, 1911.

Concerning the Exploiting of Young Engineering Graduates.

Sir: I have watched with much interest the efforts of Engineering News to raise the standing of the engineering profession in the public eye. May it continue to do so.

If the engineering profession is to attain a higher standing in the community, it will do so only through their own reforms. The banding together of engineers in societies such as the American Institute of Consulting Engineers and adoption of a uniform schedule of high fees will never accomplish the purpose. Before the ultimate object can be attained many evils which now exist must be eliminated and the reforms must begin from within and from the very bottom.

The letter by Mr. T. J. Johnston in Engineering News of Aug. 3, 1911, p. 147, strikes the keynote of the most notorious evil in the profession. (The word "notorious" is none too strong.) Let me present a few of the cases which have come under my own observation, of prominent engineers, who receive high fees for their services, making a practice of paying the wage of a cheap laborer to an assistant, with the excuse that he "never got even as much when he started out." The excuse is preposterous.

I have in mind a professor in an eastern university who is also chief engineer in a title insurance company. This man engages civil engineering graduates at $50 to $60 a month, and advances them to $75 in a year and sometimes in

nearly two years. Surely if a graduate from his own university is not worth more than that in the capacity of a draftsman, computer or fieldman, he is not worth that much either.

Another man, president of one of the engineering societies, recently employed a number of young engineers on a special engineering test. It was a 24-hr. run, and this engineer protested when he received a bill for 75 cts. an hour for the night work, claiming that half the amount was sufficient. If these young engineers were not worth 75 cts. an hour for night work they should not have been employed on such an important test.

A third illustration: A steel construction company in this city, doing a very extensive business, employs detailers at a fixed salary not much above $15 a week. The minute a new man begins to hustle a little and asks for an advancement he is fired and another man taken on. Their plea is that a man will hustle only before he asks for a raise and lay down after he gets it. If he did not get it he would leave; hence they fire him before he leaves.

The result of such actions as are illustrated above is self-evident. Such tactics are in vogue in the trades, among plumbers, carpenters, shoemakers. They are entirely out of place among engineers. If the engineers are to be treated as professional men by the community at large they must begin to treat the young engineers as such. By no means employ an incompetent man, but if a man is worth employing at all pay him the salary of a professional man and treat him as such.

Fortunately there are still a good number of engineers who act on that principle and who give the profession a good standing. But there should be more of them.

A Young Engineer.

New York City, Aug. 3, 1911.

The Advantages of the Warren Truss in Reinforced-Concrete Construction.

Sir: There are certain properties of the Warren truss, with diagonals inclined 60° to the chords, that make it peculiarly adaptable to reinforced-concrete construction. These properties are (1) the sum of the tensile web stresses in one-half of the girder = the maximum tensile chord stress and (2) the difference between the tensile stresses in two adjacent panels of the bottom chord = the tension in the intervening diagonal. On account of these properties, the design of the reinforcement in such a girder as is shown in Fig. 1 reduces itself to assigning the required amount of steel to the middle panel of the lower chord and then detouring at each tension diagonal enough steel to care for its stresses, this steel to continue across the upper chord to an anchorage over the column. The remaining bars in the lower chord are allowed to pass along the bottom chord to the next diagonal, and so on across the girder. In other words, calculate the steel for each diagonal and then pass this steel on across both bottom and upper chords, and it will be found that the lower chord is reinforced correctly for tension and the upper chord for bending in itself.

As the stresses pass through a panel point in the lower chord and through an angle of 60° up through the diagonal there will be three equal stresses to take care of with the steel bent at that point. These stresses are the tension in the diagonal, the difference in the two chord stresses and the bearing of the compression diagonal. The bars do not offer enough surface to take care of this bearing on the concrete and a bearing-plate or saddle will have to be supplied. This saddle-plate can very easily be combined as a support, spacer and bearing-plate, as is shown in the sketch in Fig. 2.

Another peculiar property of this type of construction is that all the bars in a beam will be the same length and if properly tied into the columns no dependence need be put in the concrete for shear along the face of columns. This eliminates the question of specially built units, or special rolled steel if it is not economical in price, for the only difference needed is an additional length of 40 diameters on the length of each bar, if plain bars are used, as plain bars should be embedded 50 diameters to develop full strength, and deformed bars should be embedded 30 diameters. Although, now twisted squares and spiral bars can be bought at about the same price as plain bars, they will serve the purpose as well as any special rolled sheared or built unit that can be had, and a lot better than most of them, for the diagonals in special units are nearly always of the same sectional area for each diagonal or set of diagonals and do not bear any proportion to the stresses that come upon them. It usually takes nearly all of the length of the diagonal to develop its full strength, therefore full value is not developed for the total length of the diagonal, while for this type of construction the steel is in proportion to the load it takes and there is the length from the top of each diagonal to the supporting column to develop bond.

R. T. Bagby.

McCormick, S. C., July 13, 1911.

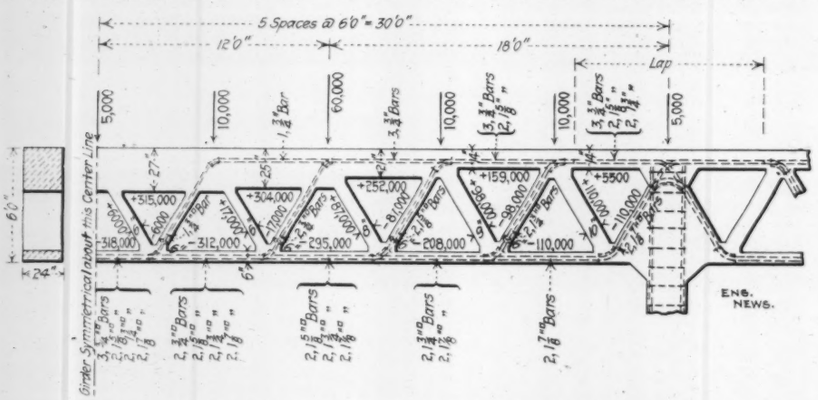


FIG. 1. A SUGGESTED DESIGN FOR A REINFORCED-CONCRETE TRUSS.

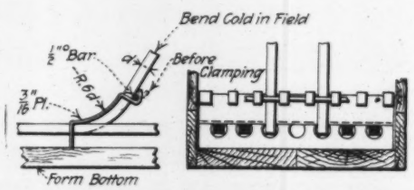


Fig. 2. Detail of Combination Bearing, Supporting and Spacing Plate to be Used at Bends in Bottom and Top of Girder.

Bacterial Standards for Public Water-Supplies.

Sir: I have read with interest the editorial review of my paper read before the Society of Engineers (England) on "The Protection of Water Supplies," contained in Engineering News of June 1, 1911, and while I am much indebted to you for the attention my paper has received, I should like to be allowed to make my meaning clearer, as it appears that in some degree the conclusions of the paper have been misunderstood. As stated in the conclusions which you quote, the object of my paper was to point out "the impossibility * * of agreeing upon any standard * * * which shall prove that the water is incapable of producing disease." In your review I am supposed "to hold out * * * * hope for the realization of an absolute bacterial standard." This was not my intention.

To put it plainly, the "scientist" (by which term I refer to the chemist and bacteriologist pure and simple, as distinct from the engineer) does not yet know enough about the matter to fix s[illegible] standard, but he does know apparently th[illegible] oli are indicators of disease. Assuming that t[illegible] are indicators of disease, it seems reasonable [illegible] demand their exclusion from all waters. Fro[illegible] the instances quoted in my paper, and fr[illegible] many others, it is only too clear that the sci[illegible]st first tells us that coli are disease indicators [illegible]d next that he only accepts them as disease [illegible]dicators when he finds it politic to do so, and [illegible]metimes brings forward many specious argument[illegible] to prove that although coli may be present in [illegible]ndance, the pollution is of animal origin (a thi[illegible] which he can never absolutely prove) and they [illegible] therefore not disease indicators. Thus, the [illegible]ngineer may have the water produced by his w[illegible]ks condemned or approved, according to the personal opinion of the bacteriologist, and it is incontestable that people often go on drinking water which is grossly polluted until an epidemic actually occurs. Further, there is distinct evidence that animal pollution will produce disease, and therefore the argument that water so polluted need not be judged by the ordinary coli standard is incorrect.

My argument is that if coli are disease indicators at London and New York, they are disease indicators elsewhere, and the fact that the consumer cannot afford to pay for new works does not lessen the fact. He may have to accept the risk, but he should do so with his eyes open. I claim that a coli standard should be generally adopted, but this is not saying that an absolute and final standard ensuring safety from all kinds of disease is possible. If a simple, rough and ready coli standard were adopted, sterilization would have to be adopted also in order to meet it, and, in my opinion, this is a thing to be desired, and one which, far from running the consumer into expense, will be likely to save a considerable amount of money.

Neither in this country nor in America is the engineer subordinate to the chemist and bacteriologist, and it was not my intention to convey any such impression. However, if the medical officer of health finds water from any works to be polluted, according to such standards as he personally may think well to adopt, without doubt the engineer will be asked to carry out such works as are required to set matters right. Thus, the work of the engineer is dependent upon that of the scientist, for as a rule a water-works engineer does not concern himself personally with analyses, but looks to the expert chemist and bacteriologist for that work.

The review further refers to the very costly things mentioned for the protection of water-supplies in my paper. It is a very common error to assume that the protection of water-supplies by means of sterilization is costly, but the results obtained by a large number of cities in America, where sterilization by means of hypochlorite has been adopted, are confirmed by similar works carried out in this country, and prove conclusively that the removal of disease germs from the most polluted water is not costly.

The *"irresponsible* scientist" mentioned in your article is a person who gives the water and sanitary engineer in this country much trouble. His statements are contradictory in the extreme, and the object of my paper was to endeavor to fix this elusive person down to some definite statement.

The admirable work accomplished during recent years in America in the sterilization of water and sewage effluents is alone sufficient to prove that all polluted drinking water could be made to conform to a coli standard, and that all sewage flowing into rivers whence drinking water is drawn could be sterilized, and that this work would not be very costly. These are not counsels of perfection, as stated in your article, but counsels of common-sense, and compliance with the rough and ready standard above referred to should be a *sine qua non*. Moreover, if I were asked to prove my point further, I could do so by reference to the many articles and papers dealing with actual works of sterilization which have appeared from time to time in your excellent journal.

With regard to the other costly works suggested in my paper, they are meant to refer to such cases as the following: I know of more than one instance where soakage cesspits exist in chalk districts close by the wells belonging to town water-works. The engineer is quite capable of dealing with such matters. The Engineering News of April 27, 1911, contained an article entitled "An Epidemic of Typhoid Fever at Lexington, Va., Evidently Caused by Leaks from Sewer to Water Mains." These are merely instances. Many similar cases exist throughout the length and breadth of England, and as long as they do not produce any obvious outbreak of illness, the

medical officer does not seem to be able to cause such defects to be made good.

The medical officer is, as a rule, a man of moderate knowledge in bacteriology and chemistry, and relies largely upon the expressed opinion of the great experts; the experts, however, as I have explained, make absolutely contradictory statements, and no one is able, therefore, to tackle the matter as it should be treated.

Where sewage leaks into water mains or into wells, the work of setting the matter right should not be referred to as being too costly to carry out. To acquiesce in the pollution of water-supplies in this manner is altogether retrograde.

H. C. H. Shenton.

28 Victoria St., Westminster, London, England, July 5, 1911.

[Possibly our choice of the term "absolute bacterial standard" was unhappy, but if the term means what we understand it to mean then we think our main thesis was correct, namely, that agreement on a single bacterial standard, applicable to all local conditions of water-supply, municipal finances and needs, is out of the question. If, in trying to maintain that thesis, we misinterpreted Mr. Shenton's ideas, we regret it.

In view of the numerous heavy demands upon municipal treasuries, many cities cannot afford either to build or to maintain and operate waterworks which will deliver a supply absolutely free from B. coli. The health returns secured from eliminating the last germ are not worth the cost of elimination; or, to put the case more humanely, more lives can be saved by devoting this money to some other line of health-protective work, not yet brought to a rational standard of attainment.

Unless perfection is the standard, how can one expect an agreement on an absolute, or perhaps we should say a single or universal and inflexible, standard?

Valuable as the hypochlorite plants established here and abroad have been, they do not yield an absolutely sterile water-supply, and would be absolutely prohibitive in cost if applied to sewage with the object of affording absolute perfection in public water-supplies.

If in the foregoing remarks Mr. Shenton thinks we have again misunderstood him, will he not state more definitely what he means by the "exclusion" of B. coli from water and by "a simple, rough and ready coli standard"?—Ed.]

Concerning Civil Service Examinations and Engineers' Compensation.

Sir: The writer was much interested in a contribution in your issue of July 27, entitled "A Civil Service Examination for Deputy Commissioner of Public Works, Evanston, Ill." The writer is a technical graduate and has passed several civil service examinations, although he has 13 or 14 years' experience behind him. He therefore takes exception to the statement that anyone who could pass the examination would necessarily be worth more than $125 a month. The ability to pass depends upon how recently a man had gone over these subjects, and the time he was able to devote to the review.

It is not likely that a practicing engineer could pass at all, simply for the reason that his mind is filled with different matters. A young engineering teacher would probably do the best, although he might never have done any practical engineering work.

The salary of such a position should be based upon the responsibilities that a man is asked to assume and not upon whether or not he remembers the formula for the area of an ellipse, or other stunt. In this case the salary is equivalent to $100 per month in a small town, for Evanston is not a place for economical living. If the man were married the salary would probably compel him to live on a back street.

Just what is expected of the successful applicant is not apparent. It should be clearly stated so that the applicant may know whether it is commensurable with the pay or not. Judging by the statements, he should be a compendium of useful mathematical information with an appendix on human nature.

It is assumed in business circles that the man who disburses a million dollars a year should be better paid than one who disburses ten thousand. Why should not the same rule apply to the engineer? The average employer wants a $100 man much as if he wanted a $300 mule; he wants to know how much somebody else paid the applicant. Isn't it the applicant's private business how much money he got elsewhere? Yet to apply for the average civil service position you must state what salary you have received. Why?

Very respectfully,

A Kicker.

[We do not believe that the writer of the above letter fully appreciates the examiners' side of the question. We do not believe the successful applicant for the position mentioned, or for any important engineering position, is selected for the mere reason that he can pass the examination. Our understanding of the contributor's statement was that the examination covered such broad ground that the questions could not be intelligently answered without considerable practical experience as well as knowledge of mathematical formulas. Certainly the requirement of three years' practical experience would exclude the hypothetical case of the young engineering instructor. The critics of civil service examinations are apt to forget the difficulties incident to selecting for a more or less important position a man totally unknown to his prospective employers. The complaint that engineers are not so well paid as men in other lines of business with equal responsibility is in many cases unfortunately too true; yet it rests with none but engineers themselves, as a whole, to better this condition.—Ed.]

Exact Formulas for Locomotive Truck Swing.

Sir: Referring to Mr. E. M. Crawford's letter in the July 20, 1911, number of this paper, the writer wishes to show that the subjects of play and of angling across the track are totally irrelevant to that of *maximum* truck swing.

The only occasion for the use of a truck swing formula is in the designing of a locomotive. It is general practice to allow for the amount of truck swing required by the sharpest curve which the rigid wheel-base can traverse.

On the sharpest curve possible for the given rigid wheel-base, the driving wheels and axles do not assume a radial position and there is no play between the flanges and rails. Consequently there is no possibility of angling across the track. The wheels and axle of a two-wheel truck, on the contrary, take a radial position on the curve, and therefore have the full amount of play between the flanges and rails; not only would this compensate for whatever play there may be at the drivers, but also, if of any appreciable amount, it would actually tend to reduce rather than increase the swing of the truck. The four-wheel truck, on account of its comparatively small wheels and short wheel-base, has also considerably more play on the curve than the driving wheels, which affect the truck swing in the same manner as in the case of the two-wheel truck.

As to the play between journal-boxes and wheel hubs, this is practically a negligible quantity in new locomotives, and no allowance should be made for it. If there be any, however, it would tend to neutralize the excess track play of the truck.

Considering, therefore, the purpose for which truck-swing formulas are employed, the formulas as given in the number of June 8, 1911, will prove correct for all cases.

H. C. Weaver.

The Baldwin Locomotive Works, Philadelphia, Pa., July 31, 1911.

A Critique of the "Good Roads" Propaganda.

Sir: It is unpopular to criticise at the present time the "good roads" movement or the statements and arguments of the leaders in that movement, but love of truth compels me to undertake the disagreeable task of questioning some of the erroneous and wrong deductions that are now being put forth.

The matter is important for many millions are being spent for good roads all over the country. There is a pretty well organized propaganda for this good roads business—call it rather raid on the public treasury. Opposing the movement, there is only a small minority and they are considering the matter as one of almost academic interest only. Prof. Ira O. Baker, for example, speaks of the movement as something that culminated years ago. This may be true for other parts of the country but is not true, I think, for the Southern states.

The good roads advocates are often vague in their statements as to the benefits to follow from the building of costly roads. A recent paper by Mr. Logan Waller Page, a government official, before the Good Roads Congress at Birmingham, Ala., on May 24, however, is so definite and quantitative that it may be thought by many to justify the attitude of the cost of the good roads advocates. Mr. Page says—"Considering the staple crops, however, enough money could be saved annually in the cost of transportation to pay for the improvement of the roads." He gives a demonstration with reference to the cotton crop in the South. If you will grant me a little of your valuable space I would like to point to the flaw (as it seems to me) in his reasoning as to this specific matter.

Mr. Page estimates the saving in hauling crops to market on the basis of the average haul, which he states is about ten miles (on this question of the correct value of average haul of farm crops, see Prof. Baker's article in Engineering News of Nov. 15, 1900, vol. 44, page 323, last column) but in estimating the cost of construction of improved roads he takes as a basis the improvement of only one-fifth of the roads, stating that nine-tenths of the hauling is over this one-fifth of the mileage. If the latter statement is true (and I do not doubt it) then the saving on only one-fifth of that average haul of ten miles, or in other words the saving on only the two miles of improved road should be considered; thus, instead of $3 per ton for the entire haul, 60 cts. per ton should be the figure, viz., at the rate of 30 cts. per ton per mile for the two miles to be actually improved, and all his other figures of saving should be scaled down in the same proportion, that is to say, the saving would be 16 cts. per bale of cotton instead of 80 cts. Therefore, the total saving on cotton and cotton seed hauling would be $2,200,000 instead of $11,000,000. If the cost of construction of the good roads be $190,000,000 (approximately) and interest be taken at only 5%, or $9,500,000, there is a deficit of over $7,000,000 annually, to say nothing of the cost of maintenance, and the saving would not "pay for it in 20 years."

Your editorial in your issue of June 22 contains two sentences which ought to be printed in italics, in black face or in the red ink of the "yellow" dailies:

> Sooner or later we must place upon the owner of the automobile the burden of paying for the wear and tear which his machine produces upon the roads.
>
> The fool propaganda of good road enthusiasts has widely disseminated the notion that good roads are cheap to build.

You have put the case none too strongly. There should be organized opposition to the waste of public money in building roads unadapted to their environment.

A. C.

Nashville, Tenn., June 28, 1911.

Temperatures of Asphalt Paving Composition Machine.

Sir: I have read with much interest the description of the machine for preparing asphalt paving compositions in your issue of July 13, and while it is quite evident that the arrangement is admirable, at the same time, there seems to be at least one point about the outfit which might make it more desirable to use some other design of portable plant. As I understand it, the gases from the oil burners pass through the aggregate once and then up through the stack. If the temperature of the upper drum is 1000° it is very possible that the exhaust temperature is comparatively high, which would mean a great loss in efficiency. It therefore seems to the writer that better economy might be secured by using a different type of dryer which permitted the hot gases to be exhausted at a temperature of about 100° F.

To secure this economy the disadvantage of using a separate portable dryer outfit would certainly be more than compensated for as the gain in efficiency would be considerable. The double shell dryer of the Ruggles type I understand is mounted on a frame and with a telescopic elevator makes a complete dryer in every detail. The hot gases pass through the inner tube and then back through the space between the shells and through the material, exhausting at about 100° F. The efficiency is stated to be in the neighborhood of 85%. It would be interesting to know whether the ultimate cost of preparing asphalt paving compositions with this Ruggles type of portable heating outfit of high efficiency and the other necessary independent machines would be less than that of a plant combining the mixing and drying in the same outfit.

Yours very truly,

John S. Nicholl.

Sharon, Mass., July 18, 1911.

The above letter was submitted to the makers of the machine in question, and we have the following reply from Mr. Kingsley, the inventor of the machine:

Sir: I have your letter of July 21, enclosing a letter which speaks of the heat in our upper cylinder running as high as 1,000° and exhausting from the stack at that temperature. The heat generated in the drum is about 1,000°, but after the material has passed through there is

not sufficient temperature to make the stack too hot to bear your hand on it. I should say the exhaust temperature is around 80 to 100°, so that we absorb all of the heat that is in the other drum, and our economy in heat is far in excess of the old type of dryer. The saving of the oil fuel is at least 20% over former heats, making our plant most efficient in all its work.

Continental Asphalt & Equipment Co.
By Henry M. Kingsley, Prest. & Gen. Mgr.
Chicago, Ill., July 29, 1911.

The Berrigan Continuous Bucket-Chain Filter Press.

Filter presses are used in a great variety of industrial practices. In addition to their use in the production of wines and other beverages, and animal or vegetable products such as syrups and oils, they are employed extensively in the mining industry for collecting gold and silver precipitates in cyanide and chlorination plants. They have been used to some extent also in the recovery of grease and fertilizer from sewage sludge. A continuous filter press of most ingenious design and with surprisingly high capacity has recently been built and exhibited at Orange, N. J. Requiring only about 1 HP. to drive it, this press can handle material continuously at the rate of 360 bu. per hour. The material is all pressed twice between cloths, the cake being turned automatically between the two pressings.

In the common method of filter-pressing, a number of layers of material are built up, each layer being enclosed in filter cloth, and the whole mass is then subjected to pressure by means of screws or a hydraulic ram. The liquid squeezed out must travel to the edges of the layers in order to escape. In the continuous press to be described, thin layers of material are pressed separately. This method has the double advantage of requiring less pressure, and therefore less power to remove the same amount of liquid, and of permitting the use of a lighter weight of filter cloth, since the cloth is supported at all points by perforated metal plates.

The general appearance of the Berrigan filter press is shown in Fig. 1, which also gives an idea of the principle on which it works. The pressing is done in buckets of semi-circular section, connected in an endless chain. The bucket chain is threaded over and under a series of five pairs of wheels mounted in a horizontal frame. The buckets themselves do not touch the wheels, the bearing being on the projecting ends of the steel rods which serve as pins in the links of the bucket chain. While passing over the top of a wheel the buckets are further apart, one from another, than they would be if the chain were traveling in a straight line, for the reason that they arrange themselves radially on the wheel, and thus spread apart at their outer edges. Conversely when passing under a wheel, the buckets are brought closer together. It should be noted, too, that with the construction shown the buckets are arranged in a semi-circle of much smaller diameter when passing under a wheel than when passing over.

Each link of the bucket chain carries both a bucket and a pressing block. The pressing block, or die, fits into the adjacent bucket when passing under a wheel and presses upon the material contained in that bucket. This action is clearly indicated in Fig. 2. The material to be pressed is poured into the buckets when they are at the top of the first wheel. The pressing blocks are then far enough removed to give free access to the buckets, as shown in Fig. 2. The material is held in the filter cloth linings of the buckets, which form themselves into long narrow bags, as indicated by dotted lines in Fig. 2, and shown photographically in Fig. 1. The buckets are formed of perforated steel plates so that the liquid pressed out through the cloth when the bucket passes down under the wheel can escape through the perforations into the galvanized iron pans below. These pans and the spouts through which the liquor is drawn off from them can be seen in Fig. 1.

The wheel at the right-hand end of the machine in Fig. 1 is the driving wheel and is armed with sprocket teeth which engage the projecting ends of the link pins. The other four wheels are simply idlers whose purpose is to change the direction of the bucket chain. The buckets are filled as they pass over wheel No. 1 at the left-hand end of the machine by means of the hopper and drum shown at the left in Fig. 1. The drum has a longitudinal slit at the bottom through which the material is delivered. Charges of proper size are measured out by means of revolving longitudinal blades inside the drum. The buckets then pass down under wheel No. 2 and the material is compressed, after which they rise upon wheel No. 3. As the buckets pass over this wheel their movement relative to each other causes a shifting motion of the filter cloth which either turns over or crumbles the cakes of nearly dry material left in the bags. As they pass down under wheel No. 4, the cakes in their new position are squeezed again, and finally they are dumped when the bags turn inside out after passing over the driving wheel.

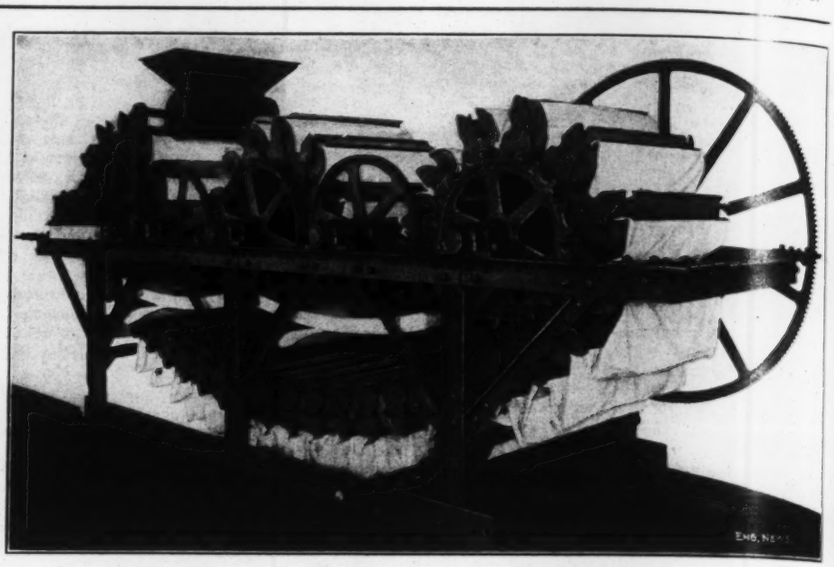


FIG. 1. THE BERRIGAN CONTINUOUS FILTER PRESS.

It will be noted in Fig. 2 that every sixth pressing block is shown solid, while the others are in the form of semi-cylindrical shells. The solid blocks are introduced to increase the weight of the bucket chain. The return portion of the chain hanging beneath the wheels includes 30 buckets and has a weight of about three tons, which is utilized to give the requisite tension in the chain. The sag of the return side of the chain is of value in providing against injury to the machine due to the accidental presence of any object, such as a bolt or wrench, in one of the buckets. In such a case the bucket chain cannot be bent, at the point where the obstruction is, to a sufficiently small radius to conform to the rim of the wheel when passing under it. It therefore stands out from the wheel, touching it only at the lowest point in the extreme case. The only result is to take up some of the sag in the return side of the chain, whereas if too little sag were allowed, something would have to give way and the machine might be damaged.

The same action takes place to some extent in the ordinary operation of the machine. With the buckets full of comparatively solid material, the return side of the chain rises several inches. But when the sag is decreased, the tension in the chain increases. Thus the pressure is automatically adjusted to the compressibility of the material in the buckets.

The capacity of the machine is limited only by the speed at which it can be safely and effectively operated. When seen in operation at Orange, N. J., by a representative of this journal, it was run at a speed which gave one complete passage of the chain in 4½ mins. As there were 54 buckets in the chain, this gives 12 buckets per min. Each bucket on the machine exhibited was 3 ft. long and held about ½ bu. of material, so that the machine was running at a capacity of some six bushels per min., or over 100 bbls. per hr. This is many times the capacity of a screw or hydraulic press requiring the same amount of space and horse-power.

It might be thought that this machine, with its

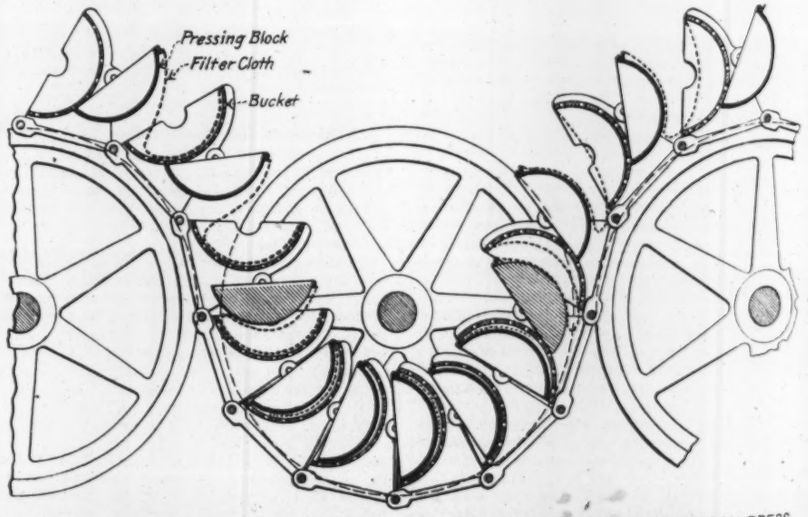


FIG. 2. DIAGRAM SHOWING THE ACTION OF THE BUCKETS IN THE BERRIGAN PRESS.

tremendously heavy bucket chain, would require an immense amount of power. It is therefore something of a surprise to find that it can be driven by hand, although, of course, at a rather slow speed. As set up for operation, a countershaft not shown in Fig. 1 was so arranged that a spur pinion on one end of the shaft meshed with the large gear shown at the right in the photograph. On the other end of the countershaft was a belt pulley of about the same diameter (say 4½ ft.) as the large gear. The machine can be turned by hand by grasping the spokes of this pulley. In operation, the machine was driven by an electric motor of a few horse-power, belted to the pulley on the countershaft.

This machine is the invention of Mr. John J. Berrigan, of 136 North Center St., Orange, N. J., who holds United States and foreign patents on its essential features. It has not yet been placed on the market, but we understand that negotiations are soon to be made for its manufacture on a royalty basis.

Blast Furnace Slag as Concrete Aggregate.

The utilization of the enormous quantities of blast furnace slag which are daily thrown off in the manufacture of steel and iron has been the subject of study for some years and gradually methods are being discovered and improved whereby this once worse than worthless by-product may be put to a gainful end. Slag brick and blocks for street paving have been made from it, it has been extensively utilized as the basic element in the manufacture of Portland cement, and crushed to proper size it is sometimes used as railway ballast or as roadway metal. In a few instances this slag has been found of value as the coarse aggregate in concrete. In Engineering News, Oct. 1, 1908, p. 354, it is recorded that the entire masonry work in the track depression of the Seaboard Air Line Ry. at Birmingham, involving some 11,000 cubic yards, was built of concrete having an aggregate of "hot pot" slag and that the concrete, both in tests and in use proved most satisfactory.

There have been, however, no very complete tests of the strength of concrete made from blast-furnace slag, and a recently published account of a series of such tests extending over two years is most welcome. These experiments were conducted by the Carnegie Steel Co., Pittsburg, Pa., and are published in a booklet* by them. From that book we have abstrated the following account.

The tests were made mainly on 1:3:6 concrete blocks, 12 ins. in diameter and 16 ins. high, tested in compression, using different materials for fine and coarse aggregate and Universal Portland cement. Blast furnace slag was used both in a granulated state as a sand and as a coarse aggregate, and for purposes of comparison, ordinary river sand and a limestone aggregate were also used.

*Furnace slags in concrete; a series of tests To Determine the Practicability of Blast Furnace Slags for Use in Concrete; by Carnegie Steel Co., Pittsburg, Pa., 1911, 5 x 8 ins.; 32 pp.; illustrated.

MATERIALS.

The various materials used are described as follows:

SANDS.—(a) Slag Sand No. 1, made at Carrie Furnaces at Homestead Steel Works Plant, by an improved method briefly described as follows: The molten slag is delivered from the furnace through the ordinary trough or runner to a concrete pit, at the edge of which the trough takes the form of a large nozzle, fitted with an annular ring, from which issues water in the form of spray delivered through a 4-in. pipe under pressure of from 30 to 40 lbs. per sq. in. This causes disintegration and partial cooling of the slag, which operations are further accomplished by the water with which the pit is partly filled, and by the force of the impact with which the slag is thus driven against the opposite wall of the pit. In appearance slag thus granulated resembles that described below as Slag Sand No. 2, except that the largest particles are much smaller and the entire product is somewhat more dense.

It is removed and loaded into cars by the usual grab bucket and crane.

(b) Slag Sand No. 2, common granulated slag as made, at many blast furnace plants, by running the molten slag directly into a tank, or brick or concrete pit, partly filled with water, in which the disintegration of the slag is accomplished by simple contact with the water. This product contains many light fluffy particles in addition to those of finer and denser character, and much of it is as coarse as popped corn, which, when the color is light enough, it rather resembles. Owing to its great porosity much of it floats until it becomes cold and saturated with water, and only the denser particles settle at once to the bottom of the tank. It is widely graded from fine to coarse.

(c) River sand, a natural product dredged from the rivers in the Pittsburg District. That from the Allegheny was selected for these experiments as being freer from coal which frequently occurs in considerable percentage in sand taken from either the Monongahela or Ohio.

(d) Bank Slag Screenings No. 1, the fine screenings from the slag crusher plant of the Duquesne Slag Products Co., containing no particles larger than 3/16-in.

(e) Bank Slag Screenings No. 2, the screenings from the same plant as above, containing particles ranging from dust up to ½-in. in size.

COARSE AGGREGATES.—(a) Bank Slag No. 1, the crushed and screened product of the Duquesne Slag Products Co., ranging in size from ½ to 1 in.

This material, as also the two grades of screenings above described and the Bank Slag No. 2 next below, is air cooled blast furnace slag, excavated from the waste banks where, months before, the molten slag had been poured and allowed to accumulate and gradually cool. The excavated slag is crushed and screened to sizes noted in Table II.

(b) Bank Slag No. 2, same as No. 1, except that the largest size pieces are 2½ ins.

(c) Machine Slag, sometimes called Pancake Slag, which is made by running molten slag from the blast furnace onto an endless chain conveyor furnished with suitable shallow cast-iron pans. The length of the conveyor, about 150 ft., is sufficient when the rate of travel is approximately 70 ft. per min., to allow the slag to cool and set—water is sprinkled on the slag just before reaching the dumping point at the end of the run, for further cooling and cracking the thin sheets of slag, and the drop into the car breaks them into small pieces, ranging in size up to about 1 in. If the machine is run at a speed much greater than that mentioned, or if water is applied too soon, the product reaches the car in a semi-molten condition or containing a considerable percentage of granulated slag greatly impairing its value.

(d) Gravel No. 1, the commercial product dredged from the rivers in and near Pittsburg, sized from 1 in. down to and including a small percentage of sand.

(e) Gravel No. 2, same as No. 1, except that the range of size of pebbles was from 2½ ins. down.

(f) Limestone No. 1, from Martinsburg, W. Va., crushed to sizes from 1 in. down.

(g) Limestone No. 2, same as No. 1, except that sizes were from 2½ ins. down.

(h) Ashes, ordinary boiler ashes or cinders, introduced into the experiment because of their somewhat extensive use in making a light concrete for fireproofing purposes.

The accompanying tables, parts of the original report, give data on the physical properties of the materials.

Tests.

The specimens were molded in sheet steel cylindrical forms and were 12 ins. in diameter by 12 ins. in height.

Care was taken to handle and treat all materials and specimens uniformly and at the same time as nearly as possible as they would be in average practice. The specimens were properly marked, dated and stored under cover until ready for testing. They were sprinkled with water daily for the first 27 days. A total of 20 specimens of each combination or mix were made, and at least three were subjected to compression test at each age interval. With the exception of a few two-year-old specimens made with bank slag screenings, all tests were made on a 400,000-lb. Olsen machine at Homestead Steel Works, under the direction and supervision of the same men. The exceptions noted were tested at the U. S. Government Testing Laboratory on a 600,000-lb. Olsen machine.

The report contains detailed tabulation of each variety of mixture, but these are all collected in

TABLE I.—AVERAGE WEIGHTS OF CONCRETES.

Sand	Aggregate.	Average weight per cu. ft.
River	No. 1 Gravel	141
No. 1 Slag Sand	No. 1 Gravel	134
No. 2 Slag Sand	No. 1 Gravel	138
River	No. 1 Bank Slag	138
No. 1 Slag Sand	No. 1 Bank Slag	121
No. 2 Slag Sand	No. 1 Bank Slag	131
River	Machine Slag	129
No. 1 Slag Sand	Machine Slag	120
No. 2 Slag Sand	Machine Slag	122
River	No. 1 Limestone	142
No. 1 Slag Sand	No. 1 Limestone	136
No. 2 Slag Sand	No. 1 Limestone	140
River	No. 2 Gravel	144
No. 1 Slag Sand	No. 2 Gravel	135
No. 2 Slag Sand	No. 2 Gravel	136
River	No. 2 Bank Slag	137
No. 1 Slag Sand	No. 2 Bank Slag	129
No. 2 Slag Sand	No. 2 Bank Slag	128
River	No. 2 Limestone	146
No. 1 Slag Sand	No. 2 Limestone	139
No. 2 Slag Sand	No. 2 Limestone	143

TABLE II.—PHYSICAL PROPERTIES OF FINE AGGREGATE USED IN TESTS.

CHEMICAL ANALYSES

	Silica	Alumina	Lime	Magnesia	Ferrous Oxide	Sulphur	Loss by Ignition	Ash
River Sand	79.28%	8.23%	5.60%	.92%	.59%	5.38%	....%	....%
Slag Sand No. 1	30.31	20.72	44.67	1.48	1.43	1.39	....	....
Slag Sand No. 2	32.24	16.32	46.51	1.45	1.91	1.57	....	....
Bank Slag Screenings No. 1	38.36	13.80	32.85	3.24	8.99	1.30	....	....
Bank Slag Screenings No. 2	37.26	16.62	39.26	3.06	2.50	1.30	....	....
Machine Slag	31.28	17.40	46.20	1.43	1.52	1.56	....	....
Ashes	....	....	....	....	....	....	47 to 65	34 to 53

GRANULOMETRIC ANALYSES

	REMAINED ON SIEVE %							PASSED THROUGH SIEVE %						
	No. 10	No. 20	No. 30	No. 40	No. 50	No. 80	No. 100	Pan	No. 10	No. 20	No. 30	No. 40	No. 50	No. 80	No. 100
River Sand	12.50	12.90	24.60	21.88	10.94	15.62	.78	.78	87.50	74.60	50.00	28.12	17.18	1.56	.78
Slag Sand No. 1	25.00	38.67	20.70	5.86	1.95	3.52	1.17	3.13	75.00	36.33	15.63	9.77	7.82	4.30	3.13
Slag Sand No. 2	24.60	41.02	18.36	4.69	1.17	4.69	1.95	3.52	75.40	34.38	16.02	11.33	10.16	5.47	3.52
Bank Slag Screenings No. 1	6.25	29.69	17.96	7.03	3.52	15.62	8.91	16.01	93.75	64.06	46.10	39.07	35.55	19.92	16.01
Bank Slag Screenings No. 2	71.88	8.98	4.69	2.34	.78	5.47	.78	5.08	28.12	19.14	14.45	12.11	11.33	5.86	5.08

	SIZE	WEIGHT
River Sand	.....	Average weight, dry, 106 pounds per cubic foot.
Slag Sand No. 1	.....	" " " " " "
Slag Sand No. 2	.....	55 " " " " "
Bank Slag Screenings No. 1	⅜" and under	49 " " " " "
Bank Slag Screenings No. 2	½" and under	117 " " " " "
Bank Slag No. 1	½" to 1"	98 " " " " "
Bank Slag No. 2	1" to 2½"	67 " " " " "
Machine Slag	1" to 2"	72 " " " " "
Gravel No. 1	1" and under	96 " " " " "
Gravel No. 2	2½" and under	104 " " " " "
Limestone No. 1	1" and under	96 " " " " "
Limestone No. 2	2½" and under	85 " " " " "
Ashes		80 " " " " "
		40 " " " " "

TABLE III.—RESULTS OF COMPRESSION TESTS ON CONCRETES MADE FROM RIVER SANDS, SLAGS AND LIMESTONES.

CONCRETES

Summary of Minimum, Maximum and Average Results. Pounds per Square Inch

1—CEMENT 3—SAND 6—AGGREGATE

MIXTURE			28 DAY TESTS			90 DAY TESTS			6 MO. TESTS			1 YEAR TESTS			2 YEAR TESTS		
Mark	Sand	Aggregate	Min.	Max	Ave.	Min.	Max	Ave.	Min.	Max	Ave.	Min.	Max	Ave.	Min.	Max	Ave.
L	River	No. 1 Gravel	639	773	720	970	1174	1055	957	1149	1023	946	1181	1054	825	873	841
F	No. 1 Slag	" "	542	642	592	792	871	840	845	1050	914	876	926	898	808	868	834
K	No. 2 Slag	" "	575	710	654	899	1021	960	1140	1252	1210	917	937	927	792	930	839
V	River	No. 1 Bank Slag	1005	1065	1033	1293	1489	1377	1377	1436	1478	1596	1856	1722	1715	1865	1778
A	No. 1 Slag	" " "	821	904	863	1013	1191	1100	1136	1330	1222	1065	1193	1131	808	1045	959
I	No. 2 Slag	" " "	946	986	963	1147	1374	1228	1291	1486	1363	1155	1391	1309	1226	1467	1367
U	River	Machine	656	692	670	844	1002	928	767	928	854	867	946	902	1091	1264	1200
E	No. 1 Slag	"	501	651	561	796	849	826	981	986	983	994	1078	1038	762	954	836
J	No. 2 Slag	"	666	777	708	837	1072	994	977	1114	1057	1001	1084	1052	890	1052	960
X	River	No. 1 Limestone	740	1007	904	1062	1272	1190	885	993	955	1156	1290	1220	1146	1254	1216
C	No. 1 Slag	" "	606	659	636	747	931	815	811	846	829	967	1053	973	720	913	831
N	No. 2 Slag	" "	788	936	869	880	1062	950	1031	1238	1122	1077	1207	1099	922	1058	990
Z	River	No. 2 Gravel	907	1164	1044	1065	1190	1108	874	991	938	931	1116	1019	1133	1204	1159
G	No. 1 Slag	" " "	614	895	644	694	801	751	870	970	913	749	842	783	707	806	743
Q	No. 2 Slag	" " "	585	720	648	872	1036	964	947	1085	1029	776	845	799	789	884	835
W	River	No. 2 Bank Slag	820	1150	1028	1246	1340	1307	1287	1548	1440	1224	1444	1328	1855	1905	1888
B	No. 1 Slag	" " "	618	814	697	973	1078	1040	948	1001	981	663	672	666	943	1167	1030
P	No. 2 Slag	" " "	648	957	837	984	1191	1076	1114	1313	1225	1117	1318	1232	1200	1413	1248
Y	River	No. 2 Limestone	936	1275	1135	1028	1190	1115	1211	1447	1322	977	1059	1026	1188	1255	1232
D	No. 1 Slag	" "	437	574	521	850	896	869	759	867	818	782	897	831	762	892	816
O	No. 2 Slag	" "	868	1129	959	1038	1102	1074	928	1052	979	889	1041	961	958	1024	998

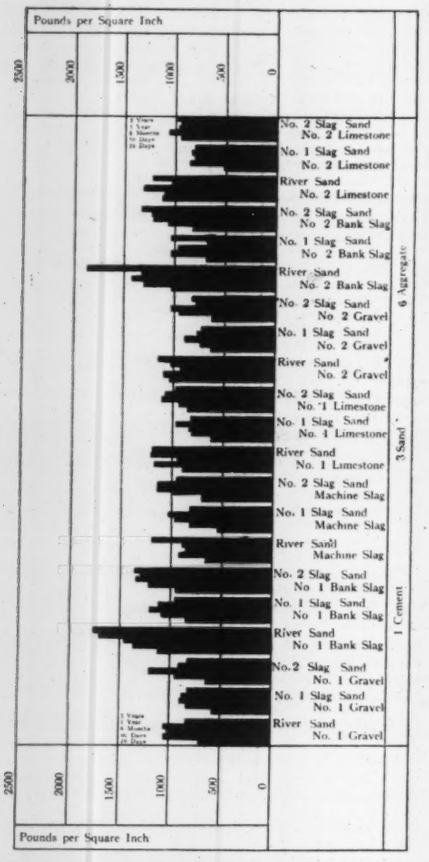


Diagram Showing Results of Tests Tabulated in Table III.

the final tabulation shown in Table III. These values are shown diagrammatically in Fig. 1.

CONCLUSIONS.

The report contains the following conclusions:

(1) The mixtures containing river sand and gravels were regarded as standard.

(2) Generally bank slags tested higher than either gravel or limestone.

(3) Bank slag No. 1 with river sand developed the greatest strength of all the coarser aggregate.

(4) Bank slag No. 2 with river sand ranks second.

(5) All slag aggregates compare favorably with the gravel standard.

(6) Both bank slag aggregates with either river sand or slag sand No. 2 can be recommended for general work.

(7) Machine slag is recommended for lighter construction where maximum strength is not essential.

(8) Bank slag screenings, and especially the No. 2 or coarser grade, developed remarkably high strength and are probably the materials par excellence for reinforced-concrete when lightness of construction with maximum strength is required.

(9) Many of these slag products have already been used in practice for several years, and compare favorably with other materials.

Deaths from Tuberculosis in 1910 have recently been announced for five states by the Bureau of the Census. Of these Maryland led with a percentage of tuberculosis, to total mortality of 12.3; New York came next, with 11.2; Ohio, with 11; Massachusetts, with 10.1, and Pennsylvania, with only 8.6%. In Maryland the colored population showed a mortality of 17.2% against 10.6 for the white population. The existence of the disease was greatest for the age period of 30-39 years in New York, but in the other four states it fell in the 20-29-year period.

Methods of Making Topographical Surveys and Their Cost.

By D. L. REABURN,* M. Am. Soc. C. E.

Two methods are in common use in this country for making topographic surveys. The older one, known as the plane-table method, has been used more extensively than any other. It is used either with or without stadia. The other, known as the transit stadia method, has been in use about 50 years.

The plane-table is used by the U. S. Coast and Geodetic Survey, the U. S. Geological Survey and the U. S. Reclamation Service; while the transit stadia has been used exclusively by the U. S. Lake, Mississippi River, Missouri River and other surveys conducted by the Corps of Engineers, U. S. A. It is also used, more or less, by engineers in general practice.

The plane-table is indispensable for geographical surveys, especially in mountainous regions of large relief. When provided with a micrometer eyepiece to the alidade, it can be used to great advantage on reconnaissance and exploratory surveys. Many thousand miles of such work has been conducted by the U. S. Geological Survey in Alaska.†

When used with stadia rods the plane-table is adapted to mapping on scales up to about 500 ft. to the inch; on larger scales than this the problem becomes a mechanical one of locating points rather than sketching, and compared to the more rapid transit stadia method, the plane-table is decidedly at a disadvantage.

The three-point method cannot be used to advantage on large scale work with the plane-table. A chained traverse line is generally required for control. In rough and brushy country this traverse work is slow, laborious and expensive. In rough country the hand level method is also very slow and expensive, and it is difficult to delineate accurately the character of the ground surface. The transit stadia method, on the other hand, is not adapted to small scale mapping of extended areas.

The writer has, however, used the transit to advantage in connection with the plane-table on 2,000 ft. to the inch work, where it was desirable to do the sketching in the field. The points were located by transit and plotted on the plane-table sheet with a small protractor.

The transit stadia is well adapted to large scale detail surveys. On such surveys the location and plotting of the detail points constitutes the major portion of the work. The transit in the hands of a skilled observer is capable of locating these points with more ease and rapidity than any other instrument. The transit is better adapted to work in brush than the plane-table, and there is not so much lost time from adverse weather conditions.

The fundamental principles governing the execution of such work along economic lines may be stated as follows: There should be a rigid horizontal and vertical control, supplemented by a less precise secondary control, upon which to base the details of the work. These principles are fully realized by the transit stadia method. The rigid control being the triangulation and precise levels, and the secondary control the stadia line. In flat country a traverse line control will sometimes be found more economical than a triangulation system.

The question of economic methods of conducting location surveys does not, as a rule, receive much consideration. The writer has observed a number of instances where money has been unnecessarily expended by not adopting methods suited to the country. In one instance, where the hand level method was in use for topography along steep brushy mountain slopes, it required the services of a transitman, levelman, topographer and nine men to make a progress of 2,000 ft. per day. A transit stadia party of six men was substituted and the progress increased to a mile per day.

During the past six years the writer has given much time and thought to the subject and tried out several of the methods in use. The transit stadia method has given the best results. A description of the methods employed, the results obtained and the cost on several pieces of work is given below.

*Division Engineer, Los Angeles Aqueduct, Surrey, Cal.
†See Eng. News, April 20, 1911, p. 483.

Irrigation Canal Location.

During the summer of 1905, about 100 miles of canal location surveys on the Kittitas Project of the U. S. Reclamation Service were made by the transit stadia method. Before the work of canal location was started, topographic maps of all the irrigable lands under the project had been made. About 300 square miles of this work was done. This survey was based on a triangulation and primary level control and was executed by the plane-table and stadia method on a scale of 2,000 ft. to the inch, with a contour interval of 5 ft. The cost of this plane-table work was from $15 to $30 per square mile.

From these maps the general arrangement of the canal system was worked out, and the approximate location, capacity and grade of all the main canals determined. The routes of the main canals were generally close to the foot hills, over rolling ground covered with sage brush. From these data the transit stadia survey for final location was made.

METHOD OF WORK.—The instrument used was an engineer's complete transit, having a wire interval of 1 in 100. The stadia rods were home-made, of Oregon pine, ⅞-in × 4 ins. × 16 ft. long. They were shod with iron, in the center of which was a small hole used for centering over a nail driven in the stake. This device was also of assistance in holding the rod in the wind. The rod was always "edged" for azimuth sights on stakes. The graduations were of the saw tooth design with numbers so that they also answered for levelling rods.

Having established an azimuth and elevation at the point of beginning, transit stakes were set along the grade contour from 400 to 800 ft. apart. These stakes were numbered consecutively. Azimuths were observed in the forward direction, and distances to feet and differences of level to hundredths were read from each end of the line. This gave a duplicate line of levels; the even and odd numbered stations each formed a series of turning points. At every transit stake the H. I. obtained from the stake occupied was checked against the H. I. obtained from a reading on the back stake by lowering the plumb bob to the top of the stake and then swinging it against a graduated leg of the tripod.

At intervals of every few miles a check in elevation was obtained by a spur line of levels to a nearby B. M. of the primary level system. The errors of closure were never more than 0.2 or 0.3-ft. for the distances of five or six miles between checks. Azimuth checks were obtained by lining in between two triangulation stations, or by throwing azimuths ahead from certain stations where flags were left, by long sights to prominent points such as chimneys, trees, etc., near the line of survey. These azimuths were thrown into the stadia line by lining in between the flag and the object sighted, as the survey advanced to the vicinity of the object.

The central contour of the belt of topography developed was traced out accurately by placing the rod upon it at frequent intervals and reading the azimuth and distance from the transit stakes. Above and below this contour sufficient random shots were taken on critical controlling topographic points for interpolating the other contours. The elevation of these random points were determined by level or vertical angle readings. The stadia slide rule was used for reducing the latter. The belt of topography developed varied from 200 to 400 ft. in width on flat ground to 50 ft. difference of elevation on steep slopes.

The field party consisted of an observer, recorder and four stadia rodmen. The method of procedure was as follows: The distance and level reading on the rear stakes were taken, the H. I. checked as explained above, and a mental note taken of the rod reading for the central contour. The transit was then oriented by means of the known back azimuth and a

check reading taken to some prominent well defined distant object, to guard against any possible movement of the instrument before the forward azimuth reading was taken. The head rodman then followed out the central contour and set the forward stake. The rear rodman on his way up to the transit gave shots adjacent to the central contour, and the two side rodmen worked along the outer limits of the belt surveyed. In this way the whole party advanced without any unnecessary doubling back.

Very few vertical angle shots were necessary on flat ground. For level shots the level reading was always taken first, the distance was then read and the horizontal cross wire moved back to the level reading before waiving off. In this way very little attention was required to keep the level bubble centered, and the speed of the observer was controlled largely by the efficiency of the recorder. The average number of stadia shots was about 250 per mile. The maximum day's run was four miles with 1,000 stadia shots. The average day's run was about three miles. The notes were plotted on a scale of 200 ft. to the inch.

The Ockerson protractor used for plotting the stadia shots is a semi-circle protractor with a small hole in the center, by which it is made fast to the paper with a needle point, around which it revolves. It has graduations so numbered that the azimuth, read from the meridian line through the point, is indicated by the semi-diameter. The semi-diameter is so graduated that distances can be laid off each way from the center. (All azimuths under 180° are laid off to the left and all over 180° to the right.)

With this protractor, stadia readings can be plotted as fast as they can be called off from a field book. A good draftsman can usually do all the drafting, including the inking of the sheets. If there are many vertical angles to be reduced an assistant will be required.

The stadia line was plotted continuously, the triangulation being used for azimuth control only. The located line was staked out by the same party before moving camp at an average rate of about two miles per day, by establishing points from the stadia line stakes. It was not necessary to establish all the location line points in this way. Frequently a mile or more of line was staked out before it began to deviate in position with reference to the preliminary stakes, as shown by a tracing of the projected line carried in the field. The time of the locating engineer was apportioned between the field and the office, examining the ground, designing sections, making projection on the topographic sheets and studying the profiles of located line.

No accurate cost data was kept of the work, but an approximation can be arrived at by taking the average daily progress (3 mi.) and the monthly cost of the party, as follows:

1 Transitman at $150	$150.00
1 Draftsman at $125	125.00
1 Recorder at $50	50.00
1 Stadia man at $45	45.00
3 Stadia men at $40	120.00
1 Teamster at $40	40.00
1 Cook at $40	40.00
Total monthly salaries	$570.00
Subsistence 9 men at $20	180.00
Feed for two-horse team	30.00
Total monthly expense exclusive of equipment cost	$780.00

Assuming 26 working days in a month, we have a daily expense of $30, or $10 per mile for the preliminary line.

Los Angeles Aqueduct Surveys.

In 1907 the writer had charge, under the direction of Mr. J. B. Lippincott, M. Am. Soc. C. E., Asst. Chief Engineer, of location surveys through the Rose Valley, Little Lake, Grape Vine, Freeman, Elizabeth and Saugus Divisions of the Los Angeles Aqueduct. The general route of the aqueduct had been determined from reconnaissance surveys, from the U. S. Geological Survey quadrangle sheets and the controlling topographic conditions. The grade elevations of certain controlling points on the line had been fixed approximately. Sections had been designed and approximate grades established between these fixed points.

What was now desired was a topographic map which would give a broad comprehensive view of the line as a whole, for determining the economic location and grades between these fixed points.

The surveys were conducted by the same general methods as described above, with modifications to meet conditions. A triangulation system of simple triangles having sides from one-half to two miles in length, furnished the horizontal control, and a line of precise levels the vertical control.

Angles were read with an ordinary engineer's transit, by the method of repetitions. The error of closure, which was seldom more than 6" to 8", was distributed equally among the three angles of the triangle before making the computation for distances. The astronomical azimuth of the base line was observed and carried through the triangulation system. The triangulation positions were computed in rectangular coordinates referred to one end of the base as the origin. At intervals of about one-half mile the stadia line was tied to the triangulation system by azimuth readings to the triangulation signals, and the position of the tie point obtained by analytical solution of the three-point problem. In some instances the tie was made by direct connection with a triangulation station, and in others by occupying one or more of the triangulation points and observing on the transit station.

The triangulation also furnished control for all subsequent surveying operations including the determination of the length of tunnels (there are in all, nearly 50 miles of tunnels on the Los Angeles Aqueduct). Section corners were also located from the triangulation system and plotted on the right-of-way map by coordinates. The located lines were also plotted by coordinates, and the distances to the points of intersection of the section lines and location line were scaled from the map. The topographic maps were on sheets 22 ins. × 30 ins. in size, drawn to a scale of 100 ft. = 1 in. Rectangular coordinate lines 10 ins. apart were projected on them and the control points plotted by coordinates.

The stadia line was first plotted to a closure between tie points, and the closure error distributed before any topography was plotted. This error was from 1 in 500 to 1 in 1,000 for lines along the grade contour, but where vertical angles entered into the line the results were not so good. The plotting of the stadia line was facilitated by the use of a special protractor made to order for the purpose. This consisted of a 14-in. 45° transparent triangle on which was a graduated semi-circle having a radius of 7 ins. and graduated as the Ockerson protractor. It is used by first orienting it on a meridian line and then moving it by means of a straight edge until the hypotenuse passes through the point from which the azimuth is to be laid off.

The country surveyed was for the most part along steep mountain slopes, in many places covered with brush. The belt of topography developed had a range in elevation of from 50 to 75 ft. The final grade adjustment raised the grade elevation in the Little Lake, Grape Vine and Freeman Divisions above the limits of the first survey, which necessitated a second one on the higher level.

The field party consisted of a party chief, transit stadia observer, recorder, four rodmen, draftsman, assistant draftsman, teamster and cook; a total of eleven men.

The assistant draftsman reduced the vertical angle stadia readings with slide rule and called off the notes to the draftsman. The party chief did the triangulation and sketched the topography after the shots were plotted. The sketching of the contours was facilitated by having the central one of the belt carefully located, which served as a guide for producing the proper topographic expression. Where the ground was badly broken and for siphon crossings over deep canyons, the sheets were mounted on a plane-table, after the transit notes were plotted, and the contours sketched in the field.

As the contours each side of the central one were interpolated, they could not be depended upon to be absolutely in position. This was of no consequence for that portion of the line in tunnels, but affected the position of the projected line where it was in conduit, or cut and cover. After the grade elevations were known this defect was remedied for that portion of the line not in tunnel by tracing out accurately one or two contours near the hydraulic grade line, and plotting them on the sheet in a dotted black line, the original contours being in burnt sienna. Any necessary changes in position of the projected line were then made before it was staked out on the ground.

The average day's run was about 1¼ miles. The number of stadia shots was from 500 to 750 per day, or about 400 to 600 per mile. The cost, including the triangulation and location of section corners was from $30 to $60 per mile.

During the spring of 1910 about 200 miles of transit stadia location surveys were made in the San Fernando Valley for the Los Angeles Aqueduct distribution system by a party in charge of Mr. J. G. Morgan.

The work was plotted on sheets 22 ins. × 30 ins. on a scale of 200 ft. to the inch, with a contour interval of 5 ft. The contours were followed out on the ground. (See Table I.)

The field party was composed of a transit man, recorder, levelman, four rodmen, draftsman and teamster. Each rodman carried a Locke hand level, for placing his rod on contours above or below the range of the transit or level, by sighting on another rod. As part of the work of spotting the rods was done by the levelman and by the rodmen themselves, the observer was able to keep four rodmen busy.

A belt of topography having a vertical width of 40 ft. was developed from one stadia line which corresponded to a horizontal width of from 100 to 1,500 ft. In some instances several adjacent 40-ft. belts were developed.

The minimum number of stadia shots per day was	240
The maximum number of stadia shots per day was	845
The average number of stadia shots per day was	520
The average number of stadia shots per mile was	300

Level control was obtained from the U. S. Geological Survey B. M.'s.

Two men were occupied 43 days in building signals and observing the angles of the triangulation system, which started from a side of the U. S. Geological Survey primary triangulation. Station marks were made of iron pipes 2 ins. × 4 ft., spread at bottom, set 2½ ft. in the ground and with a flag pole set in them.

DATA AND COST OF TRIANGULATION.

No. of stations set and observed	50
Approximate area controlled	400 sq. miles
Total salaries	$463.34
Livery and other expenses	67.43
Total cost including computations	$530.77
Cost per station	10.61
Cost per square mile controlled	1.33

Topographical Survey for Industrial Development.

During the spring of 1909 a topographic survey was made by parties in charge of Mr. A. J. Ford of a large tract of land near Riverside, Cal., for the purposes of industrial development. The work was plotted on a scale of 100 ft. to the inch with a contour interval of 2 ft. The contours were followed out. No stadia readings

TABLE I.—COST OF TRANSIT STADIA SURVEY, LOS ANGELES AQUEDUCT.
(Including Office Work, of 40-ft. Belt of Topography, 5-ft. Contours, Plotted 200 ft. to the Inch.

Month.	Feb.	March.	April.	May.	June.	Total.
Total pay-roll	$200.63	$740.52	$787.25	$794.00	$785.00	$3,307.40
Livery and other expenses	18.68	59.51	80.54	81.40	71.09	311.22
Total cost	219.31	800.03	867.79	875.40	856.09	3,618.62
Miles run	11	38	43.6	48.1	55.3	196
Days worked	9	27	26	27	26	115
Miles run	11	1.41	1.68	1.78	2.13	1.70
Cost per day	$21.93	$23.81	$28.43	$28.24	$28.53	$27.41
Cost per mile	19.94	21.05	19.87	18.21	15.48	18.46

TABLE II.—COST OF TOPOGRAPH IC SURVEYS, RIVERSIDE, CAL.

(2-ft. Contours, Plotted 100 ft. to the Inch.)

	Party No 1— Transit stadia.	Party No. 2— Plane-table.	Party No. 3— Transit stadia.	Totals.
Field and office labor	$1,844.62	$1,123.73	$313.54	$3,081.89
Subsistence	414.05	285.51	71.44	771.00
Transportation and supplies	164.00	134.70	38.00	336.70
Total cost	2,222 67	1,543.94	422 98	4,189 59
Acres surveyed	7,448.8	1,716.2	1,695.0	10,800.0
Cost per acre	$0.298	$0.90	$0.25	$0.386
No. days in field	100	78	18	196
Average progress in acres per day	74 40	21.95	94.17	55.41
Cost per day	$22.23	$19.79	$23.50	$21.38

Remarks—The cost of draftsman's work was apportioned between the two transit parties. The cost of supervision was apportioned to the three field parties.

for elevation off the contours were taken except to an occasional saddle or knoll. The ground was rolling; had a total rise of about 300 ft.; was mostly under cultivation, and the conditions were favorable. All buildings, fences, roads, etc., were located.

This work was executed by both transit and plane-table parties composed of five men each as follows: transit party; observer, recorder and three rodmen; plane-table party: plane-table man, levelman, recorder and two rodmen.

The stadia rods were 16 ft. long and provided with small sliding targets. The height of instrument at each setup was given to the rodmen, from which they determined the target setting for any particular contour. The rods were placed on the contour by the transitman in the transit party, and by the levelman in the plane-table party, by sighting the target. The men soon became expert in following along the contour, and little time was lost in spotting them. It was generally necessary to call out, up or down so many tenths but once. After a contour was followed as far as could be reached from the setup, the rodman moved his target up or down 2 ft. and returned on another contour.

A draftsman was employed for plotting the transit notes. The work was controlled by triangulation and wye level lines. The party lived on the country and hired the necessary transportation. The control work was done before the writer took charge and no data can be given for it. The number of points located by the transit parties was from 500 to 600 per day, or about 7 to 8 per acre.

Table II. gives the total costs of the topographic work for each of the three parties. This includes the salary of the topographer in charge of parties and the cost of supervision.

In comparing the costs in the table it should be noted that it was necessary in addition to the main control system to establish two points by triangulation upon each plane-table sheet, the cost of which is not included in the figures given for Party No. 2. The transit work was tied in by three pointings to the main triangulation signals. All of the men employed on the work except the topographer in charge were inexperienced in topographic work. The increased efficiency of Party No. 1 is shown in the table below for a period of three months.

Month.	Progress per day.	Cost per acre.
April	40 acres	$0.54
May	99 acres	0.23
June	122 acres	0.18

General Rules for Annealing Rolled and Forged Carbon Steel.*

1. PURPOSE.—The usual purpose in annealing miscellaneous forged or rolled carbon-steel objects is to remove existing coarseness of grain. This removal is brought about by heating the object to an annealing temperature, which varies with the carbon-content of the metal. But the rate at which the object cools from this annealing temperature influences its properties very profoundly. Hence this rate of cooling should be suited to the duties which the object has to perform in service, and hence to the properties which we seek to give it.

Under certain special conditions an annealing is required in order to remove, not coarseness of grain, but the effects of rolling or otherwise working the metal at a temperature so low as to set up serious internal stress. Appropriate treatment for these conditions is given in Section 14.

Annealing for Removing Existing Coarse Grain.

2. METHOD OF HEATING.—In the case of large objects, the heating of the interior of which lags behind that of the outside, though the early part of the heating may if desired be rapid, the final approach to the annealing temperature aimed at should be slow, so that the interior may be brought fully up to it without carrying the exterior far beyond it, because in general any needlessly high temperature is injurious, and tends to recoarsen the grain. The temperature should be held long enough at the annealing point to insure that the whole of the interior reaches that point, and that the refining of the grain may become complete. An exposure of one hour should be long enough for pieces 12 ins. thick. Thicker pieces need a longer heating.

3. CONTROL OF TEMPERATURE; PYROMETERS.—For all important work in careful hands the use of some trustworthy pyrometer is strongly recommended. But most pyrometers should be checked frequently with some standard. For those who are unwilling to take this trouble it is safer to rely on a trained eye than on an unchecked pyrometer. The operator should have clearly before him the fact that no pyrometer indicates the temperature of the interior of the object heated, and that the temperature which most pyrometers indicate is one between the temperature of the outside of the object heated and the temperature of the flame which is supplying the heat. Wherever practicable, the part of the pyrometer which is supposed to reach the temperature of the object heated should be in immediate contact with that object, and should be protected from the flame or other source of heat by a suitable insulation, as, for instance, by covering it with sand. In important cases the gas or other source of heat should be shut off for at least ten minutes before taking the observation.

4. CONTROL WITHOUT THE USE OF A PYROMETER.—In working without a pyrometer and relying on the eye, the light surrounding the furnace should be dull, and should be kept as nearly constant as practicable, in order that the eye may not be misled by the changing contrasts between the surrounding light and that of the object heated. In particular direct sunlight should be excluded, and any arc or other strong lights should be so placed that neither they themselves nor any concentrated part of their light is in the field of the operator's sight when he is estimating by eye the temperature of the object to be annealed. Allowance should be made for the brighter surroundings by day than at night, and on sunny than on dark days.

5. MAGNETIC INDICATIONS.—The annealing temperature for steels containing between 0.50% and 0.90% of carbon is that at which the metal suddenly ceases to be magnetic. This fact may sometimes be made use of for the purpose of fixing or verifying the annealing temperature.

6. ANNEALING TEMPERATURE.—In general, the higher the carbon-content the lower should be the annealing temperature. Hence different temperatures are given for different ranges of carbon-content. Further, in order to bring the interior of large objects up to an effective annealing temperature, their outside may often be raised advantageously somewhat above that temperature. Hence, for each range of carbon-content a range of temperature is given. The upper limit of this range applies (1) to larger objects, and (2) to the lower part of the range of carbon-content given.

The following ranges of temperature should be used for the several ranges of carbon-content indicated. They refer to the usual moderate manganese content. For steel with a manganese content greater than 0.75%, slightly lower temperatures suffice:

Range of carbon-content.	Range of temperature. Degrees C.
Less than 0.12%	875 to 925
0.12 to 0.29%	840 " 870
0.30 " 0.49%	815 " 840
0.50 " 1.00%	790 " 815

7. CARE IN HEATING.—Care should be taken that all parts of the object reach the same temperature. To that end it may be necessary to mask from the heat, by means of thicker part of objects of varying thickness. When the heating is nearly finished, bricks may be removed. In particular the edges should never be allowed to touch any part of the object under treatment.

8. COOLING.—After the object has been held at the annealing temperature long enough to make its temperature nearly uniform throughout, and to complete the refining of the grain, it should be cooled in a way which will give it the properties needed and is appropriate to its carbon-content. The general principles are: first, the higher the carbon the slower should be the cooling; and second, the slower the cooling the softer and more ductile the metal will be, and the lower will be its tensile strength, elastic limit, and yield point.

The greatest softness and ductility are obtained at a certain sacrifice of strength and elasticity, and the greatest strength and elasticity at a certain sacrifice of softness and ductility. For most purposes neither of these extremes is desired, and it is not only sufficient as regards quality but economical to remove the object from the furnace as soon as it has been thoroughly annealed, and to allow it to cool in air, always completely protected not only from rain and snow but from sharp drafts of air. Objects containing more than 0.50% carbon should cool more slowly till the color dies out, say at 500° C. (932° F.), as, for instance, by leaving them in the furnace. They may then be removed and cooled in air. Further, thin objects containing between 0.25% and 0.50% of carbon should be treated like those of 0.50% of carbon, unless they can be so massed together that their collective bulk will retard their cooling, so that they will collectively cool even in air with moderate slowness like single large objects.

Special Annealing Methods.

9. The foregoing methods are economical because they release the furnaces early for further use. In case special qualities are desired, the following methods may be used:

10. TO GIVE THE GREATEST SOFTNESS AND DUCTILITY of which the metal is capable, even at a certain sacrifice of strength and elastic limit (for instance, for ease of machining or to resist a small number of severe distortions), the metal should be cooled slowly, either within the furnace, or in the case of large objects, under a coyer of lime, clay, or other slow conductor of heat. The slower the cooling and the lower the temperature to which slow cooling is carried, the softer and weaker will the steel be. But for most cases for which even unusual softness and ductility are required, it suffices to remove the object from the furnace when it has become dead black, and to cool it thenceforth in air.

11. TO GIVE GREAT TENSILE STRENGTH and high elastic limit, even at a certain sacrifice of ductility, the cooling should be more rapid, the rapidity to be governed by the thickness and carbon-content of the object. Thin objects and those with high-carbon-content cannot stand so rapid a cooling as thick and low-carbon ones, lest their ductility be too far sacrificed. For instance, thick objects with less than 0.50% of carbon may be cooled completely in air, of course protected from rain or snow. Objects with 0.50% of carbon or more, and thin objects with from 0.30 to 0.50% of carbon may be cooled in air if their cooling is somewhat retarded, as, for instance, by massing them together, as happens in the case of rails

12. TO GIVE AN UNUSUALLY HIGH COMBINATION OF DUCTILITY WITH TENSILE STRENGTH AND ELASTIC LIMIT.—WATER OR OIL QUENCHING AND ANNEALING.—This process needs great care and intelligence, and should in general be used only by those familiar with high-grade steel. After holding at the annealing temperature suited to the particular steel, as indicated in Section 6, the object is quenched in oil, which should be kept in circulation. It may be quenched in water if its carbon-content is so low and its shape so simple that it is not in danger of cracking or receiving permanently harmful stress. In any event, the danger of such cracking and stress is lessened by removing the object

*Slightly condensed from "Recommended Practice for Annealing Miscellaneous Rolled and Forged Carbon Steel Objects," drawn up by Committee A-4, on Heat Treatment of Iron and Steel, of the American Society for Testing Materials, and reported to the society at its meeting of June 27-July 1, 1911, for adoption. Prof. Henry M. Howe is chairman of the committee, and the other members are Prof. William Campbell, Prof. Albert Sauveur, and Mr. Bradley Stoughton.

from the oil [ ] water before it has cooled completely, say [ ]nen its temperature has fallen to 160° C. (320° [ ].). The annealing should begin within a few [ ]ours after quenching. It is better that dur[ ]g this interval the steel should not cool belo[ ] 100° C. (212° F.) and imperative that it shoul[ ]not cool below 20° C. (68° F.).

The steel t[ ]s hardened should next be annealed by heating [ ] a temperature suited for giving the properti[ ]s needed. In general, the higher the annealin[ ]goes, the more ductile will the steel become[ ]nd the lower will be its strength and elastic li[ ]it.

For very hi[ ]elastic limit and tensile strength, anneal at 500[ ] to 650° C. (932° to 1,202° F.). In this case the [ ]uctility will be low. Some steel, such as wate[ ]springs and shafting, is annealed at 350° C. [ ]No commercial work is done below 500° C.

For interme[ ]diate tensile strength, elastic limit and ductility, best suited to the majority of cases, anneal at 600° to 650° C. (1,112° to 1,202° F.).

For the greatest ductility, with good strength and elastic limit, anneal at from 725° to 750° C. (1,337° to 1,382° F.).

The object should be held at this second annealing temperature long enough not only to allow its interior to reach it, but also to relieve the stress given in the water or oil quenching. For pieces of moderate thickness a four-hour exposure should suffice.

13. TO GIVE A MODERATE INCREASE OF STRENGTH AND ELASTIC LIMIT above that given by a simple slow cooling, without the full sacrifice or ductility which a simple air cooling would cause.—After holding at the annealing temperature suited to the carbon-content, as indicated in Section 6, hasten the cooling till the object is at a dull red, say 650° C., (1,202° F.) and thenceforth cool slowly. The hastening of the cooling may be brought about in the case of thin objects in relatively shallow furnaces by opening the furnace door till the temperature falls to dull redness; or by running the objects out into the air on a movable car-bottom, and returning them to the furnace when they have cooled to dull redness; or even, in the case of objects with not over 0.30% carbon and not too thin, by a temporary immersion in oil or even water followed by a return to the furnace. In cases in which such operations are to be performed frequently, special unfired chambers may be used for the final slow cooling, thus leaving the annealing furnaces proper available for their regular work. The results obtained in this way are not as good as those obtained with the method described in Section 11.

Special Annealing to Remove the Effects of Working at Low Temperature.

14. To remove the effects of rolling or otherwise working the object in the cold or at an unduly low temperature, the object is to be heated to about 775° C. (1,427° F.) and cooled with a slowness which should increase with the thickness, i. e., the least dimension of the piece. In the case of thin plates a mere heating to 725° C. (1,337° F.), followed immediately by slow cooling, should suffice. In the case of thick forgings, in which much time may be needed to allow severe stress to relieve itself, the sojourn at 775° C. (1,427° F.) may be prolonged for several hours, though always at the cost of superficial decarburizing.

Such annealing for steel containing less than 0.15% carbon should be at 900° C. (1,652° F.). Great brittleness may be caused by annealing very-low-carbon steel in the neighborhood of 700° C. (1,292° F.), after cold working.

Grade Crossing Accidents in New York State during July numbered 13, according to statistics given out by the National Highways Protective Society. In these accidents, 16 persons were killed and 22 injured. Automobiles figured in ten of the accidents and wagons in the remaining three. In New Jersey during the month there were seven grade crossing accidents, three of which involved automobiles. In these seven accidents, four persons were killed and three others injured.

A Tornado at Abilene, Tex., July 31 damaged nearly every business house in the city, according to press reports, bringing down most of the electric lighting and telephone wires. Two persons were killed and many others injured.

Forest Fires in California in the San Bernardino Forest Reserve were reported beyond control Aug. 1. Clifton Heights, a summer resort, was wiped out by the flames on that date.

A Sprinkler System in a Railway Yard has been recently installed by the Interborough Rapid Transit Co. at 159th St. and Eighth Ave., New York City, for the protection of cars stored in the yard during the hours of low traffic conditions on the Sixth and Ninth Avenue elevated lines. The sprinkler pipes are so placed as to be above and below the cars as they stand on the storage tracks. Water is supplied from an elevated tank. The piping is divided into a number of sections with a fire alarm bell for each, so that when a fire starts on the tracks protected by any section the water can be turned into that section alone so as to avoid the need of cutting off the current from the third rail in other sections.

Boiler, Elevator and Flywheel Accidents in the United States and Canada during the month of April killed only 23 persons, according to the list published by the Fidelity and Casualty Co., of New York, which is less than one-half the average monthly figure for the preceding six months. Only 15 boiler explosions are listed and these caused only eight deaths. The most serious explosion was at McIntosh, S. Dak., April 2, where three men were killed. There were 62 elevator accidents, in which a total of 13 persons were killed. Six of these fell down shafts, five were caught and crushed and two were killed by the fall of an elevator car. The flywheel explosions, including one emery wheel accident, were eight in number and caused the death of two men.

Lightering a Battleship through a river not deep enough for the vessel was done at Bremen on April 13, 1911. The battleship "Thüringen," built at the Weser Co. shipyard in Bremen, is of exceptionally deep draft, and could not pass the channel of the Weser from the yard to open water. Three steel pontoons were attached at each side and pumped up so as to carry 3,700 tons of the ship's weight; this raised the keel of the battleship 4 ft. aft and 3 ft. amidships. The pontoons were placed to bear against the under face of longitudinal angle-irons fastened to the side of the ship for the purpose, and were held against swinging up around this fulcrum by 16 ropes per pontoon, hitched to the outer edge of the deck of the pontoon and passing down and under the pontoon to a shackle on a gusset-plate riveted to the bottom plating of the battleship. These ropes were attached by divers. Placing the pontoons and pumping up took only 1½ days, and the equipment work on board meantime continued undisturbed. The bottom gusset-plates were later removed from the battleship in drydock. (Ztschr. d. Ver. deutsch. Ing., July 22, 1911.)

Railway Accidents for the period of three months ending March 3, 1911, are given in Bulletin No. 39, recently issued by the Interstate Commerce Commission. The total number of persons killed in train accidents during the quarter was 146, and of injured, 3,228. Accidents of other kinds, including all those in which moving trains or engines were involved, bring the totals up to 2,124 killed and 16,430 injured. Of the total number killed, 1,123 (or 53%) were trespassers, and 706 (about 33⅓%) were employees. The number of passengers killed was 53, and of these only 21 were killed in train accidents. Twenty-five passengers were killed in falling from or getting on or off cars or engines.

The total number of train accidents during the quarter was 3,205, of which 1,387 were collisions and 1,414 derailments. Passenger trains were involved in 200 of the collisions and 160 derailments. The largest number of persons killed in any one train accident was six.

Accidents on electric railways are listed separately. The total number of persons killed by accidents involving moving cars or trains was 60, with 399 injured. Of those killed, 24 were trespassers. There were 53 train accidents in which one person (an employee) was killed and 196 persons were injured.

Cement Production in the United States during 1910, has been officially reported upon by Mr. Ernest F. Burchard, of the United States Geological Survey. These figures compared with those for 1909, are as follows:

	Barrels.		Value.	
	1909.	1910.	1909.	1910.
Natural & Puzzolan	1,698,284	1,235,190	$752,209	$546,292
Portland	64,991,431	75,699,485	52,858,354	67,506,479
Total	66,689,715	76,934,675	$53,610,563	$68,052,771

A Chicago Subway Commission has been appointed by Mayor Harrison, for the purpose of preparing definite working plans for the proposed subway system to accommodate street cars and elevated-railway trains. The mayor favors a shallow subway between the curb lines, and a system that will provide for through routing of cars and trains between the three sections of the city. He does not think it necessary to provide subways much beyond the congested business district at the present time, although the system should be so planned as to permit of extension in the future. The commission, however, is given a free hand in regard to its work and plans. The members are John Ericson, M. Am. Soc. C. E., City Engineer; E. C. Shankland, M. Am. Soc. C. E., Consulting Engineer, and James J. Reynolds, Consulting Engineer. It is stated that the two latter members will receive each $12,000 per year, while Mr. Ericson will receive $8,000 in addition to his salary as City Engineer. This important step on the part of the city is the outcome of the numerous public meetings held at the City Hall (under the direction of the Mayor and the council committee on Local Transportation) at which a number of projects for subways have been presented and discussed.

A Swiss Patent Suit on Steam Turbines.—An infringement suit by the Rateau licensees in Switzerland against Escher Wyss & Co. for building the Zoelly steam turbine was decided on June 29, after six years of litigation. The "Schweizerische Bauzeitung" reports:

> After obtaining technical and legal expert testimony, the lower court decided against the plaintiffs, on the ground that the first Swiss Rateau patent covered only a combination of several previously known elements of construction but not a turbine system, whereas the Zoelly turbine built by Escher Wyss & Co. is a combination of other operative elements and therefore does not come into conflict with the Rateau patent. The Federal Court fully affirmed this judgment on June 29.

A Drought in Portions of North and South Carolina is reported to have caused the complete failure of the water-supply of Charlotte, N. C., and also the shutting down of over 150 cotton mills in those states. Pending the introduction of an emergency supply, it is stated that Charlotte was supplied with water from tank cars. The dry weather seems to have extended throughout the whole drainage area of the Catawba River and perhaps through that of the Santee River as well.

Fire-Fighting Automobiles to the number of 150 are to be ordered for the fire department of New York City, according to a statement recently given out by Commissioner Johnson. The automobile apparatus already in use by the New York fire department comprises 19 touring cars and runabouts, 4 hose wagons, 4 delivery trucks, 1 fire engine and 1 water tower. The new apparatus will include fire engines, hose carts and hook-and-ladder trucks.

Pittsburg Is To Be Spelled Pittsburgh hereafter by those who heed the rulings of the United States Geographic Board which, on July 19, 1911, reversed its former decision that the word should stop with "g" and decided to reinforce it with an "h." It appears that the earlier decision met with strong local opposition which has at last succeeded in restoring what is termed "the historic way of spelling the name of a city."

A Dam 192 Ft. High at Baltimore, Md., has been recommended as a part of the proposed improvements in the water-supply of that city. The recommendation was made by a committee acting as advisers of the mayor. The dam would form a storage reservoir with a capacity of 3,000,000,000 gals., located on the Gunpowder River about a half mile above the present Loch Raven dam. The dam will be placed on the same site as contemplated in the 237-ft. dam, recently advised by Messrs. Frederick P. Stearns and John R. Freeman, Ms. Am. Soc. C. E. One reason for deciding on the lower structure appears to have been that by so doing a $5,000,000 loan, which we understand has already been authorized, will suffice both for the dam and for the filtration plant at Lake Montebello. Apparently another reason for deciding on the lower structure is that

the reservoir thus formed will not flood certain property involved in a purchase contract entered into or proposed some time ago, over which there has been much controversy. The capacity which would have been afforded by the 227-ft. dam is reported as 21,000,000,000 gals., and the cost of such a structure (including, we presume, property and water rights) as $6,630,000.

The Additional Water-Supply System for Jersey City, completed some years ago by the Jersey City Water Co., will presumably be taken over by the city within a few months, the Court of Errors and Appeals having rendered what we understand to be the final decision in the litigation which has extended through some years past. The city lost in its contention that the company must build intercepting sewers to divert the sewage of certain villages on the drainage area involved, but won in its contention that it was not under obligations to pay some $500,000 for water rights which the contracting company claimed to have obtained from the Morris Canal Co. Under the decision, the city is compelled to accept the well-known hypochlorite plant at Boonton as a substitute for the intercepting sewers which the city claimed should be built.

Personals.

Mr. A. C. Shields has been appointed Division Engineer of the Amarillo Division of the Chicago, Rock Island & Pacific Ry.

Mr. John Kenlon, a former Deputy Chief, has been chosen to succeed Mr. Edward F. Croker as Chief of the New York City Fire Department.

Mr. R. L. Holmes, Jun. Am. Soc. C. E., Assistant Engineer of the Texas & Pacific Ry., has been promoted to Division Engineer of the Eastern Division, with headquarters at Dallas, Tex.

Mr. F. R. Blunt, formerly Train Master at St. Joseph, Mo., of the Chicago Great Western R. R., has been appointed Superintendent of the Western Division of the same road with headquarters at Clarion, Iowa.

Mr. Harry P. Davis, M. Am. Inst. E. E., formerly Assistant to the First Vice-President and Manager of Engineering of the Westinghouse Electric & Manufacturing Co., has been elected a Vice-President of the same company.

Mr. George W. Schneider, a mining engineer of Denver, Colo., has been elected Professor of Mining at the Colorado School of Mines, Golden, Colo. Mr. Schneider is a graduate of the Colorado School of Mines of the class of 1894.

Mr. James C. Wonders, former Engineer in charge of the reconstruction of the Miami & Erie Canal, and State Highway Commissioner of Ohio from 1908 to 1911, has opened an office in Bellefontaine, Ohio, as a consulting highway engineer.

Mr. Nathaniel S. Reeder, M. Am. Soc. M. E., Vice-President of the Western Steel Car & Foundry Co., of Chicago, Ill., has been elected Second Vice-President of the Pressed Steel Car Co., of Pittsburg, Pa. He will continue to make his headquarters in Chicago.

Mr. Calvert Townley, M. Am. Inst. E. E., whose resignation as Vice-President of the Connecticut Co., at New Haven, Conn., was recently noted in these columns, has been appointed Assistant to the President of the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa.

Mr. Mortimer G. Barnes, M. Am. Soc. C. E., has opened an office in Albany, N. Y., for the general practice of engineering. Mr. Barnes was formerly a member of the Advisory Board of Consulting Engineers for the New Barge Canal and was recently appointed to act in a similar capacity to State Engineer Bensel.

Mr. C. J. Tilden, Assoc. M. Am. Soc. C. E., has been appointed Professor and head of the department of Engineering Mechanics of the Engineering Department of the University of Michigan. Prof. Tilden has been a member of the faculty of Civil Engineering of this university since 1905. The chair of Engineering Mechanics was established at a recent meeting of the Board of Regents.

Mr. R. B. Seymour, Chief Engineer of the Chicago, Indiana & Southern and the Indiana Harbor Belt Rys., has resigned, and the office has been abolished. Mr. G. C. Cleveland, Assistant Chief Engineer of the Lake Shore & Michigan Southern Ry., at Cleveland, Ohio, will have charge of maintenance-of-way on the Chicago, Indiana & Southern Ry., and Mr. Otto Gersbach, Engineer of Maintenance-of-Way of the Indiana Belt Ry., will take charge of all engineering work on the latter road.

Messrs. F. W. Donnelly, of Trenton, W. M. Jacobus, of Rutherford, W. W. Wood, of Camden, J. M. Reilly, of Newark, and C. A. McCormack, of New Bruswick, have been appointed by Governor Wilson members of the New Jersey Ship Canal Commission. Mr. Donnelly has been chosen President of the Commission and Mr. Jacobus, Secretary and Treasurer. New Jersey has appropriated the sum of $500,000 for a right-of-way for the New Jersey Ship Canal, which will be a link in the proposed inland waterway from Boston to Florida, for which surveys have been made by the Corps of Engineers, U. S. A.

Mr. E. M. Herr, Assoc. Am. Inst. E. E., formerly First Vice-President in charge of operation of the Westinghouse Electric & Manufacturing Co., has been elected President of the same, succeeding Mr. Edwin F. Atkins, who declined re-election. Mr. Herr began his career as a telegraph operator on the Kansas & Pacific Ry., and was promoted to Station Agent. In 1881 he entered Sheffield Scientific School, Yale University, and graduated in 1884, when he entered the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Ry. as an apprentice. Later he became a draftsman, Assistant Engineer of Tests, and Engineer of Tests, for the Chicago, Burlington & Quincy R. R., and from 1887 to 1890, was Superintendent of Telegraphy and Division Superintendent of the same road. From 1890 to 1898 he was successively Division Master Mechanic of the Chicago, Milwaukee & St. Paul Ry., Superintendent of the Grant Locomotive Works of Chicago, Ill., Superintendent of Motive Power of the Chicago & Northwestern Ry. and of the Northern Pacific Ry. In 1898 he was made Assistant General Manager of the Westinghouse Air Brake Co., becoming General Manager a year later. He was elected First Vice-President of the Westinghouse Electric & Manufacturing Co. in 1905.

Mr. D. W. Lum, M. Am. Soc. C. E., Chief Engineer of Maintenance-of-Way and Structures of the Southern Ry., is to retire on Sept. 1. Mr. B. Herman, former Principal Assistant Engineer, has been appointed Acting Chief Engineer of Maintenance-of-Way and Structures, and Mr. T. H. Gatlin, former Engineer of Maintenance-of-Way at Knoxville, Tenn., has been appointed Assistant Chief Engineer of Maintenance-of-Way and Structures. Mr. Lum is a native of Newark, N. J., and was educated in the public schools of that city and at Newark Academy. He began his railway career in 1873, when he was engaged in engineering work on the construction of railways in Iowa and Minnesota. In 1876-'77 he was Assistant Engineer of the Hackensack River and Bergen Tunnel improvements of the Delaware, Lackawanna & Western R. R. For four years following he was a computor in the office of the Supervising Architect, Treasury Department, Washington, D. C. In 1881 he returned to railway work as Division Engineer of the Kentucky extension of the Chesapeake & Ohio Ry. In 1885 he was Division Engineer of the East Tennessee, Virginia & Georgia Ry., later becoming Chief Engineer of the same road. Upon its absorption by the Southern Ry. he became Superintendent of Maintenance and Structures of the Western District of the latter railway. From this position he was promoted through the various grades to Chief Engineer of Maintenance-of-Way and Structures, which position he has held since 1904.

Obituary.

Col. George W. E. Dorsey, a member of the Board of Directors of the American Mining Congress since 1904, died at Salt Lake City, Utah, on July 12.

Albert Gallatin Cummings, an inventor of railway switch apparatus, and a former Master Mechanic of the Pennsylvania Steel Co., of Steelton, Pa., died at his home in Millersburg, Pa., on July 31. He was born in New Hampshire in 1842 and served in the Fifth New Hampshire Regiment as a captain during the Civil War.

M. B. Piper, Jun. Am. Soc. C. E., was drowned while bathing in the Columbia River at Big Eddy, Oregon, on Sunday, July 23. He was a graduate of Leland Stanford University of the class of 1910, and was employed as an inspector on the Dalles-Celilo Canal by the Engineer Department of the U. S. Government.

Col. Lawrence L. Bruff, an authority on ordnance and author of several works on explosives, guns, etc., died in the Pennsylvania Hospital at Philadelphia, Pa., on Aug. 4. Col. Bruff was born in Maryland in 1851 and gra[duated] from the United States Military Acad[emy] at West Point in 1876. He was appointed [2d Lieu]tenant of Artillery, and after three [years] of field service was commissioned First [Lieu]tenant in the Ordnance Department, in which [branch] of the service he continued up to the [time] of his death. For nine years, 1891 to 190[0] he was Instructor of Ordnance and Gunnery [in] the Military Academy at West Point, and [his] treatises on ordnance subjects are used as [text-books] there.

Engineering Societies.

COMING MEETINGS.

SOUTH DAKOTA ENGINEERING SOCIETY.
Aug. 23-26. Annual meeting at [Deadwood, S. Dak] Secy., R. G. Culbertson, [Mitchell, S. Dak.]

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 29-Sept. 1. Annual convention at Chicago, Ill. Secy., W. O. Thompson, N. Y. C. Car Shops, East Buffalo, N. Y.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 12-15. Annual meeting at St. Paul, Minn. Secy., Clarence R. George, Houston, Tex.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12-15. Annual convention at Atlantic City, N. J. Secy., A. P. Dane, Boston & Maine R. R., Reading, Mass.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.
Sept. 13-15. Annual convention at Glenwood Springs, Colo. Secy., F. D. Morris, P. O. Box 1052. Colorado Springs, Colo.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 13-15. Annual convention at Gloucester, Mass. Secy., Willard Kent, Narragansett Pier, R. I.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 19-21. Annual convention at Spring Lake, N. J. Secy., N. T. Wilcox, Lowell, Mass.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 21-23. Annual meeting at Toronto, Ont. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

MICHIGAN GAS ASSOCIATION.
Sept. 20-22. Annual meeting at Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 25-27. Annual convention at Chicago, Ill. Secy., Preston S. Millar, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 26-29. Annual convention at Grand Rapids, Mich. Secy., A. P. Folwell, 239 West 39th St., New York City.

AMERICAN MINING CONGRESS.
Sept. 26-29. Annual session at Chicago, Ill. Secy., J. F. Callbreath, Denver, Colo.

LEAGUE OF AMERICAN MUNICIPALITIES.
Oct. 4-6. Annual convention at Atlanta, Ga. Secy., John MacVicar, Department of Streets, Des Moines, Iowa.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Annual convention at Atlantic City, N. J. Secy., H. C. Donecker, 29 West 39th St., New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Oct. 10. Annual convention at Washington, D. C. Secy., Wm. H. Connolly, Washington, D. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 10. Annual convention at San Francisco, Cal., followed by trip to Japan. Secy., Joseph Struthers, 29 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 10-12. Annual convention at Colorado Springs, Colo. Secy., C. C. Rosenberg, Bethlehem, Pa.

St. Louis Railway Club.

The annual outing is to be held Aug. 10 at the Litchfield-Hillsboro Chautauqua grounds, 60 miles from St. Louis.

Atlantic Deeper Waterways Association.

The annual convention will be held at Richmond, Va., Oct. 17-20. The secretary is Mr. Addison B. Burk, Crozer Bldg., Philadelphia, Pa.

Institution of Mining and Metallurgy.

The council has on behalf of the Institution accepted an invitation from the Canadian Mining Institute to hold a joint meeting in Ottawa or Montreal, about the first week in March, 1912.

International Exposition of Inventions.

The first exposition in this country will be held at St. Louis, Mo., Sept. 11-16 "for the exhibition, demonstration and promotion of patented machines, devices and processes." The secretary-manager, Mr. F. W. Payne, states that previous expositions have been held with success in England. The exposition is particularly intended to serve as a market place where new inventions can be brought to the attention of those interested.